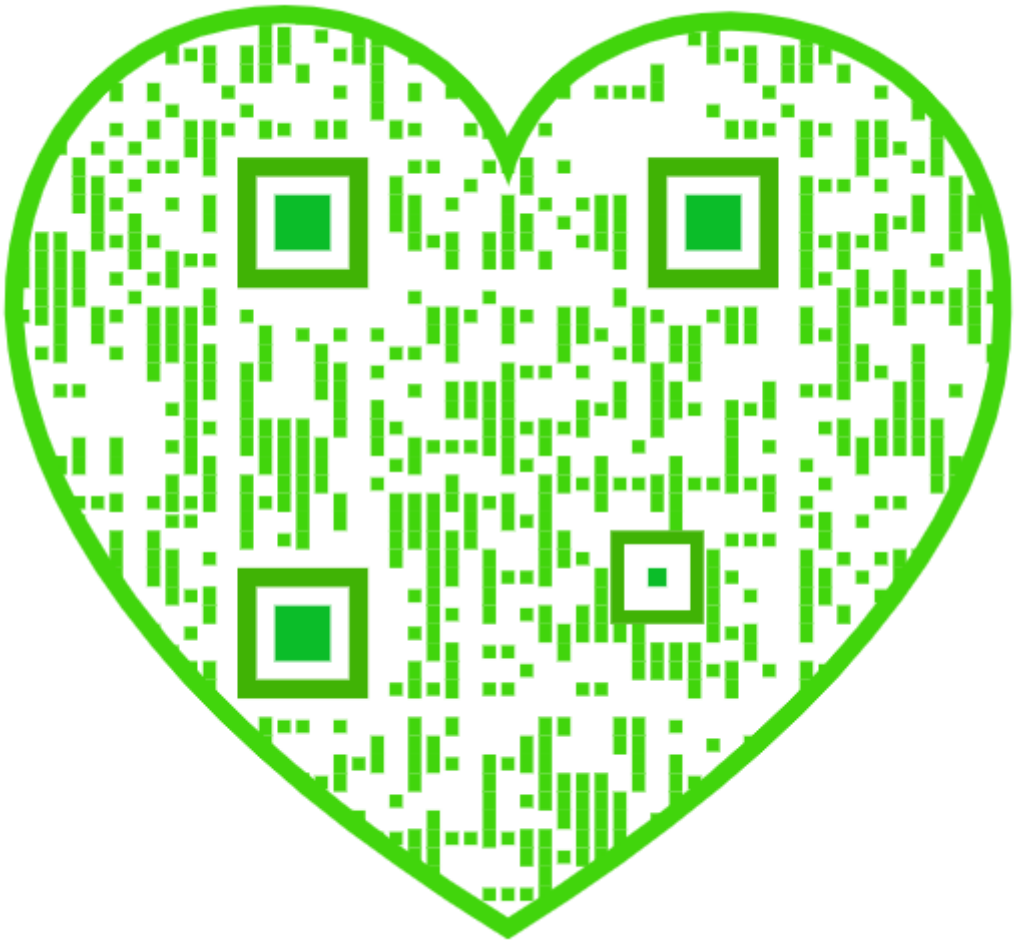
R. Bel

FLAX AND HEMP.



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TO

ROBERT MACINTYRE, ESQ.,

OF RENFREW,

THIS VOLUME IS DEDICATED,

AS

A MARK OF GRATITUDE AND ESTEEM,

BY

HIS HUMBLE SERVANT,

THE

AUTHOR.

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PREFACE.

"To the North of Lake Huron, and between Georgian Bay and the Ottawa River, the superficial covering of the country is almost invariably a yellow sand. This, also, overlies the clays of this region, which are exposed only in river cuttings. This sand is most largely developed along the principal rivers of the district, and it also covers St. Joseph's Island, and part of the Grand Manitoulin. It is largely developed on the Dog and Kaministiquia Rivers, and spreads over a considerable tract below the Great Falls of the Michipicoten, as well as over a smaller area on the Batchehwahnung River. The Goulais River, in its lower stretch, flows in a very tortuous course between mountain ranges, through a wide and fertile valley, which has yellow sand as a subsoil over a great part of its area. This yellow sand also extends far and wide over the higher table-lands of the Thessalon and Mississagui Rivers. On either side of the Spanish River, below the great bend, it forms an extensive plain, bearing a heavy growth of pines, and it is also found in large patches north of that part of the coast lying between the mouth of the Mississagui and Spanish Rivers. The sand is widely spread almost all along the valleys of the White-fish and Sturgeon Rivers.

"Much of the region thus covered, lies within the District of Algoma, and this great arenaceous deposit may hence be conveniently designated as the Algoma sand."—*Extract from Geology of Canada*, 1863, pp. 907-8.

In a soil like that just described, hemp and flax will flourish well.

The wide distribution of hemp is remarkable, but easily explained when we consider that it is an annual which requires only a few months of summer temperature to bring it to full perfection. It thrives in the north of Russia, and in Italy. If we compare the summer temperatures of these countries, we shall not find so great a difference as we might be led to expect by considering only their latitudes, or their mean annual temperatures. Thus Petersburgh and Moscow, in N. latitude 59° 56′ and 56° 45′, have mean summer temperatures of 62° 06′ and 67° 10′ of Fahr., while Milan and Rome, in N. latitude 45° 28′ and 41° 53′, have summer temperatures of 73° 04′ and 75° 20′.

From observations taken by Professor Kingston at the Magnetic Observatory, the mean summer temperature for Toronto, in N. latitude 43° 30′, or the mean of June, July and August, is 65° nearly.

The latitude of Quebec is 46° 49' N. and its corresponding mean derived from old printed records is 67°.

The latitude of the north shore of Lake Huron corresponds very nearly with that of Quebec, and its summer temperature is much the same as that of Penetanguishene, whose summer temperature drawn from very scanty observations is said to be 68° nearly.

As regards its waters, soil, and climate, therefore, there is no better district in Canada for the growth and manipulation of hemp, than that described in the extract from the geological survey.

Several able writers having within the last few years drawn attention to the importance of the culture of flax and hemp, we may make use of the facts which they have collected, and apply them to Canada.

We cannot safely rest our claims to be counted among the foremost nations of the world in agriculture, upon what we have already done.

The possession of the raw material, or of any other incidental or natural advantage, is daily becoming a less and less important element in the race after national wealth, and manufacturing industry. Skill and intelligence, on the other hand, are daily acquiring a greater proportionate power and importance.

A. KIRKWOOD.

FLAX AND HEMP.

FLAX. (*Linum Usitatissimum.*)

"Flax and hemp," says Olivier de Serres, "are of extremest value to man, both in sickness and in health, in life, and even in death." The Scriptures make the flame of flaxen fibre the type of the short and ephemeral duration of all human joys and sorrows. "A bruised reed shall he not break, and smoking flax shall he not quench." (Matt. xii. 20.) That is, he will forbear to extinguish so brief a light as that of flax already smoking and half burnt out.

To innumerable individuals of the great human family does flax supply the various items of clothing, writing material, bedding, fuel, medicine, external as well as internal; manure, material to aid the painter's art, and, indirectly, animal food of the highest nutritive qualities; and when properly managed, it affords that inestimable blessing to a population,—a constant source of remunerative employment.

The flax plant belongs to the natural family of Linaceæ, so named from the botanical name (*Linum*) of the genus to which it belongs. The species are found chiefly in temperate parts of the world, with a few in tropical regions; most are remarkable for the tenacity of the fibre of their inner bark. The native country of the flax plant is unknown; but as it was cultivated by the earliest civilized nations, it is probably a native of oriental regions, from which it has travelled into other countries.

Description of Plant.—It is an annual, with long and slender but fibrous roots, which penetrate to a considerable distance into the soil, where this is loose and friable. The stem is smooth, simple and erect; branched, or, as usually cultivated, branching only towards the top; from one and a half to three feet in height. It consists of a pith and woody part, with the layer of bost fibres covered with cuticle on the outside.

The leaves are alternate, sessile, linear-lanceolate, and smooth. The flowers, of a blue color, are arranged in a corymbose panicle. The sepals, or green outer leaflets of the flower are five in number, ovate acute, slightly ciliated, nearly equal to the capsule in length. The petals, blue in color and five in number, are obscurely crenate, comparatively large, and deciduous. The stamens are equal in number to the petals and alternate with them, having their filaments united together near their bases into a kind of ring. The ovary, or young seed-vessel, is divided into five cells, and is surmounted by five stigmata. Capsule, or *boll*, roundish, but rather pointed at the apex, divided into five perfect cells, each of which is again subdivided by an

imperfect partition, thus forming ten divisions, each of them containing a single seed. These seeds are oval in shape, flattened or plump, smooth and shining, of a brownish color externally, but sometimes white; always white internally: the seed-coat mucilaginous, and the kernel of the seed oily and farinaceous.

The flax plant was cultivated by the earliest of the civilized nations of antiquity, and is becoming every day of still greater importance. It may be seen from the paintings in the tombs of Egypt, that it was early cultivated in that country, and it has been proven that it was so, from a microscopic examination of mummy-cloth. We read in the book of "Exodus" of the flax and the barley being smitten by the plague of hail in Egypt, and in "Joshua" of the spies, who had been sent to report on the state of Jericho, being hid with stalks of flax. Subsequently, it was much cultivated both by the Greeks and Romans.

The flax plant is one of the humblest of those which are cultivated, and yet it is one of the most important, thought not particularly useful as an article of diet. Its slender stem, narrow leaves, and beautiful blue flowers, give it an elegant appearance. Its smooth and shining seeds have their external coating formed of much condensed mucilage, while the white kernel is gorged with oil, especially valued for its drying properties; and the refuse or oil-cake affords a nutritious diet for cattle. The fibre of flax separated from the stem may be made use of for cordage, for coarse fabrics, or for the finest cambrics and lawns. Hence it is a principal object of attention in Russia and Poland, a highly successful culture in Belgium, carried on also in Germany, France, and Italy, the object of frequent legislative enactment in England, and of recent most successful cultivation in Ireland. Hence, also, it was re-established by the late Pasha in Egypt. It has been frequently recommended for culture in India on account of its fibre, as it already is in almost every part of that country for its seed. As much attention, also, has been given to the husbandry of flax in the United States and Canada as to any other branch of rural economy.

The encouragement given by Government to the culture of flax in Ireland has been of considerable advantage. The quality of the flax has been so greatly improved that the Jury of Class IV. of the Exhibition of 1851, stated—"The entire collection shown by the Royal Society for Improving and Promoting the Growth of Flax in Ireland is so highly valuable, and so clearly illustrates the great advanees which have been made and the important service which this society has rendered to the country, that they determine to mark their high appreciation of their labours by recommending them to have one of the Council Medals."

But, notwithstanding the endeavors of successive governments, the supply of home-grown flax has never reached the extent required by the manufacturers of the United Kingdom. At present, it is considered that the consumption is equal to 160,000 tons. About 70,000 tons were, for several years, annually imported; or more precisely, in the year 1831, 46,820 tons; in the year 1843, about 72,000 tons were imported, but in 1853 no less than 94,000 tons, or an increase of about 31 per cent. in the decennial period. If the 160,000 tons be valued at an average of forty, or, according to others, at fifty pounds a ton, the amount is enormous. To this must be added "£1,500,000, the value of 650,000 quarters of linseed, used as seed and for crushing purposes; and about £500,000, the cost of 70,000 tons of oil-cake,

which are annually imported, in addition to that made at home, for feeding purposes. The quantity of flax fibre necessary to supply the demand of the United Kingdom would consume the produce of 500,000 acres; while in Ireland, during the year (1853), only 136,000 were cultivated, and, probably, not a fourth of that quantity in the rest of the kingdom." (Wilson.) The seed is imported from India, Egypt, Russia, Sicily, Prussia, and Holland; and the oil-cake from France, Germany, and the United States.

Mr. Fane is of opinion that—"Under proper arrangements, the whole might be home-grown. If all were, the money result would be enormous, because every ton of fibre involves the growth of eight tons of flax straw—eight tons of straw being required to produce one of fibre; and every ton of straw involves the production of six bushels of seed, worth at least 6s. 6d. a bushel. These would give the following money result:—

1,680,000 tons of straw, producing six bushels of seed to each ton, at 6s. 6d. a bushel, would give	£2,496,000
160,000 tons of fibre, at £50 a ton, would give	8,000,000
	£10,496,000

Without advocating, or considering it desirable, that all the increasing quantities of flax required by the manufacturers of the United Kingdom should be grown in that country, we may take advantage of the information collected as applicable to our own. It has, indeed, been objected, by Mr. H. S. Thompson, that if forty stone of flax (value 7s. 6d. per stone) is the average produce of a reasonably well-cultivated acre of flax, 70,000 tons of imported flax would require 280,000 acres of land for its cultivation, which is "clean and in good tilth," *i. e.*, "precisely in the state in which it is best fitted for producing corn," and, "on an average, at least four quarters." "The 280,000 acres required to produce the flax imported, would therefore produce, if cropped with wheat, 1,120,000 quarters, worth (at 7s. per bushel) £3,136,000; which approaches tolerably near to the estimate given by Mr. Nichols of the value of the imported flax, viz., £3,490,000." But these objections are made to the occupation of good land in a country like England, where the whole quantity is but limited, and do not apply to countries like America, where there is an unlimited extent of fertile land. (Royle.)

"If we refer to the statistics of British and Irish exports, we find that in 1813 there were shipped from the United Kingdom, in round numbers, 91,000,000 yards of linen, and that the exports of 1853 reached nearly 130,000,000 yards; the total value of all kinds of linen and yarn exported in the former year being £3,702,052, and in the latter £5,910,355."—*Belfast Mercury.*

Though the culture of flax is considered by some as not particularly eligible for the best cultivated lands of England, it is yet in other countries accounted a most desirable object of attention, being in Belgium called "the Golden crop," and in Ireland "the Rent-paying crop." In Russia, it is one of the principal objects of culture, and has been much extended by the continual advances of English capital; while in Egypt, the culture was re-established by the vigorous but despotic policy of Mehemet Ali. In Canada, it is to be hoped that we may be induced to cultivate it in suitable localities. In such situations it will be found an eligible crop if the population is numerous and labour abundant. Mr. Nichols says:—"The quantity of flax which ought to be cultivated in any locality, must, in some measure, be governed by the quantity of labour there obtainable. One acre in a hundred, and one in fifty,

have each been named as a suitable proportion. It is calculated that an acre of good flax, as it stands in the field, containing, say, about fifty stone of fibre, will afford employment for from twelve to fourteen weeks to a man skilled in the several processes of its preparation." But it is not to men only that flax affords employment, but also to women and to children; as it is skill rather than strength that is required for many of the operations.

Flax grown in Russia, Prussia, and Egypt, is, generally speaking, coarser than that grown in Holland, Belgium, and France. But it is the latter, which is chiefly reqnired in increasing quantities. Mr. McAdam says:— "It is certain that all hot countries, or those which, like Russia, have a short, warm summer, cannot furnish fine flax fibre, but it is precisely coarse fibre that is now so much wanted. The bulk of fine flax used in the linen manufacture is trifling compared with the coarse. A Belfast or Leeds mill of 5,000 spindles will consume only 200 to 250 tons of flax annually; while one of the same size at Dundee or Kirkaldy, will consume 1,000 to 1,200 tons. Belgium, Holland, France, and Ireland can supply the world with fine fibre; but Russia and Egypt cannot keep pace with the demand for coarse."

Canadian flax will bring on an average from £40 to £50 a ton in Dundee and Belfast, and these prices ought to pay for the growth and export.

PRODUCTS OF THE FLAX PLANT.

The useful products of the flax plant consist of the seed, and of the fibre. Linseed or the seeds of the flax plant, are oval, pointed in shape, compressed with a sharp margin; brownish colored, smooth, and shining on the outside, but white internally, and without odour. The outside has a bland, mucilaginous taste, in consequence of the skin of the seed being covered with condensed mucus. The white part, or almond of the seed, has an oily taste, from containing fixed oil, which is separated by expression.

These seeds analysed by Meyer, consist, in one hundred parts, of 15·12 mucilage (nitrogenous mucilage with acetic acid and salts, according to some), chiefly in the seed-coat, 11·26 fatty oil in the nucleus. In the *husk*, emulsin 44·38, besides wax 0·14, acrid soft resin 2·48, starch with salts 1·48. In the *nucleus*, besides the oil, gum 6·15, albumen 2·78, gluten 2·93, also resinous coloring matter 0·55, yellow extractive with tannin and salts (nitre and the chloride of potassium and calcium) 1·91, sweet extractive with malic acid and some salts 10·88.

The condensed mucus which abounds in the testa of the seed is readily acted on by hot water, and a viscid mucilaginous fluid is formed, in which are two distinct substances; one completely soluble in water analogous to common gum, called Arabine by chemists; the other portion is merely suspended, and is considered to be analogous to the Bassorine, found chiefly in Gum Bussora, and in Cherry-tree gum. Alcohol produces a white, flaky, and acetate of lead, a dense precipitate in mucilage of linseed.

Linseed oil, which we have seen is contained in the kernel of the seeds, is obtained by expression, and may be either cold-drawn, or, as usually obtained, after the seeds have been subjected to a heat of 200°. The former, as in the case of cold-drawn castor oil, is paler, with less color and taste than linseed oil prepared with the aid of heat. This is of a deep yellow or brownish color, of a disagreeable smell and taste, specific gravity 0·932, soluble in alcohol and ether; differing from many other fatty oils, especially in its property of drying

into a hard, transparent varnish—a peculiarity which is increased by boiling the oil, either alone, or with some of the preparations of lead.

The yield of oil from a bushel of East Indian seeds is 14¾ lb. to 16 lb.; of Egyptian, 15 lb.; of Sicilian, 14½ lb. to 15½ lbs.; of Russian, 11 lb. to 13 lb.; of English or Irish, 10¾ to 12 lb.

Linseed oil, according to Sace, is composed of Margarine and Oleine in nearly equal proportions. But the oleic acid of linseed differs from that of other fatty bodies. The anhydrous acid is composed of carbon 46, hydrogen 38, oxygen 5. The margaric acid is as usual composed of carbon 34, hydrogen 33, oxygen 3. The glycerine obtainable from linseed oil in large quantities, is also similar to that procured from other fats.

Linseed, after having had the oil expressed from them, are in the form of a flat mass, commonly called *oil-cake*. This being reduced to coarse powder, forms the linseed meal which is so commonly employed for making poultices, though these are also formed of the simply powdered seeds. From the chemical composition, it is also evident how nourishing the linseed is likely to be, and, indeed, from experience is well known to be, for fattening cattle.

In the imports of flax, the terms *codilla* and *tow* are very often used as synonymous, but codilla forms the first workings in the dressing of flax, and is longer than tow; it is more or less dirty, and in consequence sometimes cheaper than tow.

CHEMICAL CONSTITUENTS OF THE FLAX PLANT.

In addition to the composition of the seed, it is interesting to know that of the plant in general. This we are able do in a very satisfactory manner, from Dr. Hodge's "Lecture on the Composition of the Flax Plant," and his paper read before the British Association, at Belfast, 3rd September, 1852. In this he communicated the history of a crop grown by himself for experimental purposes, and the progress of which he was able carefully to watch, from the sowing of the seed to its conversion into dressed flax for the market. From this we obtain the following information:—

"July 28th.—One plant of flax, in seed, was taken—height above ground, 31 inches, root, 5½ inches long; length from surface of field to first branch, 24 inches. About five inches of the lower end of stem had become yellow. The weight of entire plant was 71·1 grains. It was cut into three portions, which were separately incinerated, with the following results:—

1. Root and lower part of stem weighed, dried, 6·60 grains, gave 0·094 ash=1·424 per cent.

2. Capsules and branches, dry, weighed 9·47, gave ·293 ash=3·094 per cent.

3. Middle portion, dry, weighed 5·55, gave ·143 ash. Ash in dry stem 2·622 per cent.

August 10th.—One plant taken—entire length with root, 37 inches; length from surface of soil to branches, 29 inches; stem of a light straw color leaves withered on ten inches of stem; capsules ten in number—seeds green; weight of entire plant 71 grains; branches and capsules, 31·8 grains; water in plant 45·335 grains; solid matter in do., 25·665: inorganic matter in do., 1·006 grains.

PER-CENTAGE COMPOSITION.

Water	63·852	Dry
Organic matters	34·732	96·08
Ash	1·416	3.92
Total	100·000	100·00

August 25th.—The pulling of the crop was begun. A plant was taken and examined; weight of entire plant, 62·40 grains; weight of capsules, 22·50.

PER-CENTAGE COMPOSITION OF STEM.

	In fresh plant.	Dry.
Water	56·64	
Organic matters	41·97	96·89
Ash	1·39	3·11
Total	100·00	100·00

Water in straw of plants as sent to the steeping works, after 14 days' exposure to the air in stooks, 12·2 per cent.; water in air-dried capsules, 11·84 per cent.; weight of the air dried flax, with bolls produced on the experimental field, 7·770 lb.

COMPOSITION OF THE CROP.

One hundred parts of the ash of the dry straw and capsules had respectively the following composition:—

	Ash of Straw.	Of Capsules.
Potash	20·32	16·38
Soda	2·07	6·25
Chloride of sodium	9·27	12·98
Lime	19·88	13·95
Magnesia	4·05	3·91
Oxide of iron	2·83	0·38
Sulphuric acid	7·13	14·51
Phosphoric acid	10·24	23·26
Carbonic acid	10·72	6·37
Silica	12·80	0·67
Total	99·31	99·66

The proportion of nitrogen contained in the straw and capsules was ascertained to be as follows, per cent.:—

1. In the straw dried at 212° ..... 0·53
2. In the capsules or bolls, do. ..... 1·26

The general results of the examination of a specimen of flax straw taken from the experimental crop, are as follows:—"The presence of a volatile oil having been indicated, a quantity of the stems of the plant carefully deprived of the seed capsules, were distilled with water containing common salt; and from the distillate which was without action on litmus, I obtained an oil of a yellow color. Five pounds of the stems afforded about ten grains of this oil, which had an agreeable, penetrating odour, and the distillate of the stems suggested the peculiar smell which is remarked on entering a room where flax is stored. The solutions obtained on examination were found to contain wax; traces of chlorophylle; a peculiar green resin; a bright brown gum resin, which presented some of the characters of the principle which Pagenstecher termed *linen*, but could not be indentified with it; a modification of tannic acid which afforded a gray precipitate with perchloride of iron, but was not affected by solutions of isinglass or tartar emetic; gum, not affected by

solution of borax, or basic silicate of potash; a brown coloring matter; albumen; casein; starch; pectin; cellulose; and salts."

The result of Dr. Hodge's experiments has been further placed in a very clear light by Mr. Wilson. The object of these was to ascertain the relative proportions of the produce of flax, and also the distribution of inorganic matter in them. The flax employed had been steeped in the ordinary way, and was found to contain 1·73 per cent. of ash. Of this, air-dried straw, 4,000 lb. weight were taken, which produced:—

Of dressed fibre	500 lb.
Of fine tow	132 "
Of coarse tow	192 "
Of fibre in all	824 lb.

These products contained:—

In the dressed flax	4·48 lb. of ash
" fine tow	2·08 "
" coarse tow	2·56 "
Or, in the whole of the fibre	9·12 lb. inorganic matter.

So that 59·08 lb., which the crop had withdrawn from the soil, remained in the useless portion, while only 9·12 lb. were carried off in 824 lb. of the dressed fibre and tow.

Analysis of the flax plant and of the soils in which it is grown were first carefully made by Sir. R. Kane, and afterwards by Dr. Hodges and others. They have been repeated by Messrs. Mayer and Brazier, in the Laboratory of the Royal College of Chemistry. The localities from which the latter obtained their specimens of flax, by the aid of Mr. A. Marshall of Leeds, were Esthonia, or Estland, Livonia, or Lievland, Courland, and Lithuania. The first of these districts, with the second and third mentioned, are situated on the eastern shores of the Baltic; the fourth is the only inland country.

From their analysis, the following comparative table was made, from which it will be readily seen, in what points the ashes of these different specimens agree in composition.

	Lievland.	Courland.	Lithuania.	Estland.
Potash	43·42	37·44	36·61	25·70
Soda	....	3·74	3·06	8·37
Lime	21·35	25·39	24·09	26·41
Magnesia	7·79	7·71	7·45	11·74
Sesquioxide of Iron	1·15	1·13	1·04	1·02
Manganese	....	Trace.	....	....
Chloride of Sodium	...	1·94	3·75	1·67
" of Potassium	1·31	....	....	....
Phosphoric Acid	10·94	8·31	14·30	15·47
Sulphuric Acid	5·66	5·89	3·65	4·64
Silicic Acid	8·38	8·45	6·05	4·98
	100·00	100·00	100·00	100·00

We also append, in a tabular form, the result of Sir R. Kane's analysis of this plant, taken from his paper, read before the Royal Dublin Society, on the 6th of April, 1847.

	A	B	C	D	E	F	G
	Courtrai District.		Antwerp District.				
	Heestelt.	Escamaffles.	Hamme Zog.	Not named.	District in Holland.	Dublin.	Armagh.
Potash	9·69	30·62	26·67	28·62	21.35	11·78	6·60
Soda	24·16	None.	16·88	0·48	12·65	11·82	6·61
Lime	19·37	22·04	22·15	21·19	21·30	14·85	23·67
Magnesia	4·34	4·45	4·70	4·05	3·50	9·38	4·22
Sesquioxide of Iron	5·66	2·03	1·31	2·53	2·74	....	14·10
Alumina	0·56	0·58	0·86	....	1·67	7·32	....
Manganese	Trace.	Trace.	Trace.	....	....	....	1·12
Sulphuric Acid	7·93	8·33	8·18	13·43	11·22	3·19	9·30
Phosphoric Acid	14·10	15·78	10·66	12·19	12·82	13·05	7·29
Silicic Acid	3·85	4 54	3·20	3·36	6·18	25·71	0·94
Chloride of Sodium	10·34	11·63	5·49	14·15	6·57	2·90	26·15
	100·00	100·00	100.00	100·00	100 00	100·00	100·00

In the ashes, both of the Belgian and of the Russian specimens, we meet with a very large amount of alkali (nearly 40 per cent.): the quantity, too, of phosphoric acid is very considerable (from 10 to 15 per cent.). These analyses then furnish a further proof that flax must be classed among the most exhausting crops, for, the amount of valuable mineral substances which it removes from the soil considerably exceeds the quantity which is generally extracted from it in the form of wheat or corn.

From a statement of Mr. McAdam, it appears that one rood of land yields about 12.7 cwt. of recently pulled flax plant. If we take this number as the basis of calculation, and the average per centage of ash at 3·53 lb., of alkalies at 39·58 lb., and of phosphoric acid at 12·51 lb., we find that a flax crop removes from a rood of land not less than 12·21 lb. of alkalies, and 5·94 lb. of phosphoric acid. On the other hand, we have learned from the researches of Mr. Way (*Royal Ayricultural Journal*, vol. vii. p. 593), that a rood of land, which has served for the cultivation of wheat, loses (an average taken from a great number of analyses) about 7·5 lb. of alkali and 6·9 lb. of phosphoric acid. These figures show that the amount of phosphoric acid in the flax crop closely approaches that of the wheat, whilst the latter extracts only about half the quantity of alkali which we find in the former. Hence, it would appear, that a flax crop is at least as exhausting as a crop of wheat.

There is, however, one striking point of dissimilarity between the cultivation of wheat and that of flax, and we are indebted to Sir R. Kane for having for the first time brought this point under the notice of the farmer in a forcible manner, viz.: — "That while the mineral ingredients which we remove from our fields in wheat, or cerealia in general, become constituents of food, and enter in this manner into a circulation, from which, even under very favorable circumstances, they return to the soil only after the lapse of some time, the woody fibre of flax, as a necessary preliminary to its being used by man, is separated to a considerable extent from those very mineral substances which are so essential for its successful growth. This mineral matter, when economized in a proper manner by the farmer, may be returned to his field to keep up the equilibrium of its fertility.

The vegetation of the flax plant resembles in this respect the growth of the sugar cane, from the culture of which we extract a material consisting entirely of atmospheric constituents. The inorganic substances taken up by the plant are only instruments used in its production, which should be as carefully preserved as tools in a manufactory, and will then do further duty in promoting the elaboration of future crops."

Messrs. Mayer and Brazier then directed their attention to the soils upon which the different specimens of flax had been grown, samples, of which through the kindness of Mr. Marshall, had likewise been forwarded to Dr. Hoffman. These soils all gave a brownish colour to boiling water, owing to a portion of the organic matter being soluble in that menstruum.

From their various analyses, Messrs. Mayer and Brazier obtain, by calculation, the following amounts of constituents of 100 parts in the soil :—

	Lievland.	Courland.	Lithuania.	Estland.
Potash	0·5011	0·3241	0·5466	0·3726
Soda	.....	0·1320	0·0452	0·0480
Lime	0·3751	0·7816	0·4980	0·7955
Magnesia	0·2006	0·1304	0·1805	0·3619
Alumina	1·1919	1·8731	2·1418	2·0102
Sesquioxide of Iron	1·8076	2·3767	3·1900	2·0206
Manganese	Trace.	Trace.	Trace.	Trace.
Chloride of Sodium	0·0455	0·0247	0·0421	0·0790
Sulphuric Acid	0·1539	0·0880	0·1206	0·1618
Phosphoric Acid	0·1399	0·0538	0·0805	0·1597
Organic matter	4·7176	4·0300	4·3442	4·8630
Insoluble residue, after deducting organic matter	91·0634	88·4872	88·4724	88·2364
	100·1966	99·3016	99·6619	99·1087

The insoluble residue constituting the greater portion of the soil, was fused with carbonate of potash. Upon calculation, they yielded the following results per cent. :—

	Lievland.	Courland.	Lithuania.	Estland.
Lime	Traces.	1·8727	0·8778	2·0120
Alumina	11·6270	6·1145	2·2452	5·7549
Sesquioxide of Iron	Traces.	Traces.	Traces.	Traces.
Phosphoric Acid	Traces.	Traces.	None.	Traces.
Silicic Acid	79·3424	81·5000	85·0938	80 5676
	99·9694	92·6224	88·2168	88·3345

In all the four soils they found, comparatively speaking, considerable quantities of a kali, especially potash, and also of phosphoric acid. They closely resemble the Belgian soils analysed by Sir Robert Kane, as may be seen from the tables which they borrow from Sir Robert's paper.

	Heestert.	Escamaffles.	Hamme Zog.	Not named.	Holland.
Potassa	0·160	0·123	0·068	0·151	0·583
Soda	0·298	0·146	0·110	0·206	0·306
Lime	0·357	0·227	0 481	0·366	3·043
Magnesia	0·202	0·153	0·140	0·142	0·105
Alumina	2·102	1·383	0·125	0·988	5·626
Sesquioxide of Iron	3·298	1·663	1·202	1·543	6·047
Manganese	Trace.	Trace.	A trace.	No trace.	Trace.
Chloride of Sodium	0·017	0·030	0·067	0·009	0·023
Sulphuric Acid	0·025	0·017	0·013	0·026	0·023
Phosphoric Acid	0·121	0·152	0·064	0·193	0·159
Organic matter not driven off at 100° p. cent	8·123	2·361	4·209	3·672	5·841
Clay	14·920	9·280	5·760	4·400	17·080
Sand	75·080	84·065	86·797	88·385	60·947
	99·703	99·600	99·975	100·081	99·783

That we may have a complete view of what is required in soils for the successful culture of flax, we adduce Sir R. Kane's analyses of three Irish soils and one Belgian, from the Report of the Flax Improvement Society of Ireland. The Irish soils, as described by Mr. McAdam, were from the counties of Londonderry and Tyrone, and were considered very good for flax. The Belgian was from Duffel, in the Province of Antwerp, and may be taken as representing a third-rate class of flax soil in that country, requiring much manure, but producing good crops. The large proportion of sand, and the little moisture in this last, deserve notice:—

	Irish No. 1.	Irish, No. 2.	Irish, No. 3.	Belgian.
Silica and Silicious Sand	73·72	69·41	64·93	92·78
Oxide of Iron	5·51	5·29	5·64	0·66
Alumina	6·65	5·70	8·97	1·11
Basic Phosphate of Iron	0·06	0·25	0·31	0·21
Carbonate of Lime	1·00	0·53	1·67	0·35
Magnesia, Alkalies, and Sulphuric and Muriatic Acids	0·32	0·25	0·45	0·12
Organic Matters with Nitrogen	4·86	6·67	9·41	2·74
Water	7·57	11·48	8·62	2·03
	99·78	99·78	100·00	100·00

CULTURE OF FLAX.

The importance of flax culture being admitted, we may devote a few words to the objections which are usually alleged against it. These chiefly consist of the opinions entertained respecting the exhausting nature of a flax crop. This is certainly true, as Dr. Royle says, where everything is taken from the soil, and nothing returned to it; but the elementary principles of which both cotton and flax fibre, as well as sugar, consist, are now known to be obtained almost entirely from the atmosphere. Therefore, by taking away only the cotton, the flax, or the sugar, and returning all the other parts of the plant to the soil, these products will impoverish the soil as little as it is possible for any culture to do. This, as far as flax is concerned may be effected by some of the improved methods of preparing the fibre, and by feeding cattle on the oil-cake of the seeds, and thus returning all the other constituents

which had been taken from the soil. Mr. Nichols observes that every farmer will be enabled, by applying the seed of his flax crop to that purpose, to obtain a supply of the richest manure, which, with the offal separated from the fibre in course of preparation, will serve to renovate the soil and secure its undiminished fertility. This we find fully proved by the foregoing and other analyses of the different parts of the plant, and of the soil in which it has been grown, as well as of the products obtained in the improved steeping and preparation of the fibre.

The analyses of Mayer and Brazier correspond closely with those made by Sir R. Kane, of specimens of Belgian flax; and their conclusions also coincide with his, that while the mineral ingredients which we remove from our fields in wheat, become constituents of food, the woody fibre of flax is separated from those very mineral substances which are so essential for its successful growth; and they forcibly observe that "The inorganic substances taken up by the plant, are only instruments in the production of flax, which should be as carefully preserved as tools in a manufactory, and will then do further duty in promoting the elaboration of future crops."

Climate.—One of the most important considerations in attempting the culture of flax in new situations or countries is that of climate, though one that is frequently neglected. On this subject, Mr. McAdam has made some very just observations. Though the climate of the British Isles is well adapted to the growth of this plant, those districts which possess the most equable temperature will be found the most suitable. A regular supply of genial moisture in spring, without an excess of wet in autumn, is most favorable. The severe droughts which frequently occur in spring in Belgium often destroy the crop. If, after springing to the height of two or three inches, a long continuance of drought should occur, with a hot sun, the heat parches up the earth, as the delicate leaves of the plant are unable to exclude the scorching rays from the surface soil, and the roots have not penetrated sufficiently deep to secure a supply of moisture. Flax is then in the most critical state; the plant droops, turns a whitish yellow, and, if the drought continue long, dies on arid tracts of land. In such a case flax may be beneficially watered.

When the plant acquires a sufficient height to thoroughly cover the ground, dry weather becomes comparatively harmless; but occasional gentle showers are very needful to produce a regular and vigorous growth. In fact, a slow, steady growth, from the germinating of the seed to the maturity of the plant, is requisite for the quality and yield of fibre. Hence it is found that in countries approaching the northern limits of the temperate zone, the short hot summers induce too rapid growth, and although the quantity of fibre produced is pretty large, it is never of a fine reed. This is strongly exemplified by Russia, as, out of an export frequently reaching 40,000 to 50,000 tons per annum, none sells higher than £48; whereas, in Belgium and Holland, the price often reaches £150 and £180 per ton. The best samples of British flax sell for £65 to £70, or even £85 per ton.

For the same reason, insular climates or long lines of coast, whose position insures a more equable temperature and continued supply of moisture from spring till autumn, are found to produce the best flax. In such the plant springs up to a height of thirty or forty inches, in a straight, slender stem, with few or no branches, and only two or three seed vessels to each stalk.

So, also, Mr. Nichol says:—"Flax will bear a good deal of moisture, and, in fact, thrives best in a moist climate. Hence the peculiar suitableness of England for its growth; being more generally humid than that of the continent, especially in the western counties. Indeed, long-continued drought is the chief enemy the flax-grower has to dread." (p. 447.)

The hot summers of Russia and Egypt cause a dryness and brittleness of fibre, and prevent its retaining that elasticity, pliancy and oiliness which characterize the flaxes of Belgium, Holland and Ireland.

In Egypt, though the plant attains great luxuriance in the rich alluvial soils of the Nile, yet the fibre does not attain fineness and softness, and, notwithstanding the efforts made to improve the culture and preparation, its value has not exceeded £44 per ton.

Culture.—In connection with the climate we may notice peculiarities of culture in different countries.

In Flanders, a great variety of crops are raised, the farms being for the most part small; the majority varying from eight or ten to twenty and thirty acres. Every Belgian farmer, whether large or small, grows flax sufficient to keep himself and his people employed when not at work on the land.

The cultivation of flax in Flanders is conducted with the greatest care. The ground is well ploughed, rolled, enriched, with liquid manure, harrowed, and when the seed is sown again harrowed in with a light harrow, and the surface rolled. The fields when thus accurately prepared display an extreme degree of neatness and smoothness. The liquid manure is prepared with considerable care. It consists of the urine of cattle in which rape-cake has been dissolved, and in which the cleansings of privies from the neighbouring towns and villages have been mixed; and is collected in subterranean vaults of brick work. About 2,800 gallons (beer measure) are allowed to the English acre

In Russia the flax is cultivated with less care, and without any manure in the Ukraine. The time of sowing is from the 25th of May to the 10th of June, and that of reaping, from the end of August to the end of September. The flax is about four months in a state of vegetation.

SYSTEMS OF STEEPING.

In *Schenck's process* the temperature of the steep water is kept at 80° to 90°, but may be increased to that which is favorable to the process of fermentation,—for the effects depend upon the destructive power of fermentation quite as much as in the old process. A great saving of time is effected —as not more than seventy-two hours is required for the fine, and about ninety-six hours for the coarse qualities; and a more uniform fibre is moreover produced.

A disadvantage of this process, in comparison with some others, is that during fermentation, the same kind of gaseous exhalations are given off as in the ordinary method. These gases have been stated by chemists to consist chiefly of carbonic acid and hydrogen in nearly equal parts. Dr. Hodges has clearly shown that the fermentation is of a peculiar character, traces only of acetic acid being found, while butyric acid is generated in large quantities. Other objections have been stated—such as that the fibre was weakened

when overheated; and another, that a most offensive matter adhered to the straw, and that, in the process of scutching, the scutchers could not bear the smell of the irritant dust which flew off. With regard to other objections—such as that the yield of fibre would be less, that it would be weakened, and that the linen made from it would not bleach properly—a committee of the Royal Irish Flax Improvement Society, after carefully conducted experiments, reported, first, that the uniformity of temperature had the effect of increasing the yield of fibre. With regard to the weakening of the fibre, the committee ascertained that the flax steeped in the ordinary way spun to 96 lea yarn, and that by Schenck's system to 101 lea yarn. In the second, the cold-steeped gave 60 lea, and the hot-steeped 70. The third objection was submitted to an extensive bleaching firm, whose evidence in favor of the hot water process was very decided.

We here subjoin Dr. Hodge's observations on his experimental crop, and his analysis of the steep-water. He first observes that the crop, having been air-dried, was removed to the steeping works at Cregagh:

"It was there placed in stacks, and after some time prepared for steeping. The first operation for this purpose is the removal of the valuable bolls or capsules. This, in these establishments, where the cost of labour is carefully considered, is usually most expeditiously and perfectly effected, by means of a machine composed of two cast-iron rollers, to which motion is communicated by a belt from the steam engine. Between these the flax is passed, and the capsules bruised so that the seed can be readily shaken out. Having been deprived of its bolls by this machine, it was found that the 7,770 lbs. of flax were reduced to 52 cwt., or 5,824 lbs.

Of the portions of the plant removed by the seeding machine, 910 lbs. consisted of clean seed, 1,036 lbs. of husks, leaves and sand. The loss experienced by the flax in steeping was 13 cwt. From the 52 cwt. of seeded straw, the produce of the experimental crop, there remained 6 cwt. 1 qr. 2 lbs. of marketable fibre.

The taste of the steep-water, at first, is rather agreeably acid, but followed by the peculiar plant-like taste of the flax. By the addition to the liquid of carbonate of lime, its acidity is destroyed. Contrary to what has been stated, in some reports on this subject, the liquid, I found, at the conclusion of the process, yields merely a trace of acetic acid, and in numerous experiments no trace of the evolution of sulphuretted hydrogen could be detected at any stage of the fermentation. When the flax is allowed to remain in the vats after the usual time, a new series of changes, and a fresh and rapid extrication of gas take place. I have made, during the last three years, numerous experiments with respect to the composition of the steep-water, from several establishments, and also from the common steep-pools, which afforded me some interesting results, and satisfied me that the fermentation which is induced by steeping flax in water resembles the so-called butyric acid fermentation; merely traces of acetic acid, and invariably large quantities of butyric acid having been detected in every case. In fact, the fragrant butyric ether, so extensively employed in the preparation of pine-apple rum, and in flavoring confectionery, might readily be obtained in large quantities from the stinking waters of the flax-pool.

To ascertain exactly the effect produced by steeping, and the composition of the steep-water, I obtained from the works at Cregagh a sample of flax straw unsteeped, a portion of steeped straw taken from the same lot, and a gallon of the steep-water taken from the vat immediately after the removal of the flax. The composition of the ash obtained by burning the extract of the steep-water, and the samples of the straw, is given in the table. The spring water employed at the works is moderately hard, indicating, on Dr. Clarke's scale, 8 degrees. It was not considered necessary to deduct the ingredients supplied in it, as these would add but little to its fertilising value. An imperial gallon of the liquid of the vat was found to contain, in grains and tenths:

Organic matters	136·7
Inorganic matters	131·4
Total solid matters	268·1 grains.

COMPOSITION OF THE ASH OF THE FLAX STRAW BEFORE AND AFTER STEEPING, AND OF THE INORGANIC MATTERS OF THE STEEP WATER.

100 parts of each respectively contained:—

	Unsteeped flax.	Steeped flax	Ash of the steep water.
Potash	13·88	11·40	19·31
Soda	5·33	4·17	——
Chloride of Potassium	——	——	3·83
Chloride of Sodium	6·47	3·28	21·24
Lime	18·86	17·69	8·23
Magnesia	4·10	5·50	10·18
Oxide of Iron	5·40	5·76	2·02
Sulphuric acid	11·16	4·07	6·10
Phosphoric acid	9·63	11·87	3·77
Carbonic acid	10·37	20·06	23·30
Silica	15·23	15·78	1·12
Sand	——	——	0·60
	100·43	99·58	99·77
Ash per cent. in the straw	3·89	2·59	——

100 grains of the dried extract of the steep-water contained 1·56 nitrogen,=1·89 grains of ammonia; therefore an imperial gallon would be capable of supplying five grains, and a vat, containing 3,000 gallons of water, 2 1-10 lb., worth about 1s. 2d. to the farmer; while the same amount of liquid, placed on his field, would convey to them about the same amount of phosphoric acid.

By the kindness of the proprietors of the steeping works at Cregagh, who have liberally given me an opportunity of inspecting the books of their establishment, I am enabled to give the following statement of the changes which 100 tons of flax undergo when treated by Schenck's process. 100 tons of air-dried flax straw yield:—

	Tons.
1. *By seeding*—33 tons of seed and husks, leaving of seeded flax	67·00
2. *By steeping*—67 tons of seeded flax yield of steeped straw	39·50
3. *By scutching*—39½ tons of steeped straw yield of dressed flax	5·90
" " of tow and pluckings	1·47

WATT'S PATENT PROCESS.

The advantages of Schenck's method of preparation are sufficiently considerable to ensure its adoption at once in an uncertain climate like that of the British Isles. But it remained to be proved whether the process of fermentation was essential to the separation of the fibre; and whether, if it was got rid of, we might not obtain an equally good fibre, avoid the noxious exhalations, and even utilize the products of the steep-water, which had previously been a nuisance. Some are of opinion that this has been done by Watt's method of preparing flax.

In this process the solution of the cementing matters of the flax straw, and the separation of the fibre are effected, not by the ordinary methods of fermentation, but by exposing the straw to the action of steam, in a chamber of peculiar construction, and afterwards subjecting it to pressure, applied by means of heavy metal rollers. The first operation consists in placing the seeded flax in a chamber formed of plates of cast iron.

The chamber used measures about twelve feet in length, and is about six feet broad, and six feet in depth, and contains about fifteen cwt. of flax. On the top is a tank for containing water, also of cast iron, about eighteen inches deep, the bottom of which forms the roof of the chamber, and through which

passes a tube, furnished with a valve. There are two doors in the ends of the chambers, through which the flax is introduced, and these, when the steam is admitted, are secured by screws. A false bottom, formed of perforated iron plates, such as are used in malt-kilns, is raised about six inches from the bottom of the chamber; and, resting on this, there is an upright throw-pipe. The chamber being filled with flax, and the doors secured, steam is admitted, and when the straw has been thoroughly saturated with moisture and softened, a weight is placed upon the valve on the top, so as to confine the steam, which, as it strikes against the cold bottom of the water-tank forming the roof of the chamber, is condensed, and made to descend in streams of distilled water, which dissolve the soluble matters of the softened straw, washing them into the lower part of the chamber. The liquid, as it accumulates, is conveyed into a reservoir, and employed as food for cattle. The analysis of this liquid is given at page 22.

Towards the conclusion of the process, when nearly all the soluble matters have been removed, the liquid is allowed to collect until it rises above the false bottom, and, by placing a weight upon the safety valve, in the roof, the pressure of the confined steam causes it to ascend in the throw-pipes, by which it is discharged in showers over the straw. The throw-pipes, it may be mentioned, are not essential, and in some of the chambers they are not used. In their stead, a square iron reservoir is placed on the top of the chamber, and communicating with it by a pipe with a stop-cock, into which the liquid accumulated in the chamber is pumped, and discharged occasionally over the straw.

In from twelve to eighteen hours the steaming process is completed, and the straw, when withdrawn from the chamber, is immediately subjected in small parcels to the successive action of two pair of heavy iron rollers, by which it is pressed into flat tape-like bands, and deprived of nearly all the moisture contained in it. The longitudinal pressure—this pressure also removes a considerable portion of the epidermis, or outer envelope, and facilitates the removal of the woody matter in scutching. Each pair of rollers used exerts a pressure equal to 10 cwt.

The after treatment of the pressed straw does not present any remarkable difference from the system pursued in the hot-water steeping establishments. The straw is secured between rods, and suspended in a drying chamber, heated by the waste steam of the engine. The arrangements for this purpose consist of rooms with floors formed of spars. Below this flooring passes a pipe conveying steam, by which the air admitted by openings at the bottom of the chambers is heated, and made to ascend through the flax. The circulation of the air is ingeniously effected by a series of revolving heaters kept in action below the steam-pipe.

The following extract from the Report of a Committee of the Royal Flax Society gives the results of an experiment made at Messrs. Leadbetter's works, Belfast :—

In this experimental trial, a quantity of flax straw, of ordinary quality, was taken from the bulk of the stock at the works, weighing 13¾ cwt. with the seed on. After the removal of the seed, which, on being cleaned thoroughly from the chaff, measured 3¾ imperial bushels, the straw was reduced in weight to 10 cwt. 1 qr. 2 lb. It was then placed in the vat, where it was subjected to the steaming process for about eleven hours. After steeping, wet rolling, and drying, it weighed 7 cwt. 0 qr. 11 lb.; and on being scutched, the yield was 187 lb. of flax; and of scutching tow, 12 lbs. 6½ oz. fine, 35 lbs. 3 oz. coarse. The yield of fibre, in the state of good flax, was, therefore, at the

rate of 13½ lb. from the cwt. of straw with seed on; 18 lb. from the cwt. of straw without seed; 26¼ lb. from the cwt. of steeped and dried straw.

The time occupied in actual labor, in the processes from the seeding of the flax to the commencement of the scutching. was 13¼ hours. to which, if eleven hours be added for the time the flax was in the vat, twenty-four hours would be the time required up to this point. The scutching, by four stands, occupied six hours sixteen minutes. But, in this statement, the time required for drying is not included, as owing to some derangement in the apparatus, no certain estimate could be made of the actual time required in that process. It would appear, however, that about thirty-six hours would include the time necessary, in a well-organised establishment, to convert flax-straw into fibre for the spinner.

The cost of all these operations in this experiment, leaving out the drying, for the reasons noted, appeared to be under £10 per ton of clean fibre for labor, exclusive of general expenses.

A portion of the fibre was sent to two spinning mills to be hackled, and to have a value put upon it. The valuation of the samples varied from £56 to £70 per ton, according to the quality of the stricks of fibre sent, and the yield on the hackle was considered quite satisfactory.

Appended to this report is a note of the time occupied in the different processes during the experiment, and of the number of persons employed in each.

It is to be hoped that so promising a plan may, on more extended experience, be found fully to warrant the high anticipation formed from what is already known concerning it.

(Signed on behalf of the Committee)

RICHARD NIVEN, *Chairman.*

Belfast, 3rd Nov., 1852.

Appendix.—Note of the time occupied, and of the number of persons employed in each of the processes witnessed by the Committee, on the experimental trial of Mr. Watt's system of preparing flax fibre.

	No. of Persons employed.		Time occupied.	
	Men.	Women and Boys.	Hours.	Minutes.
Seeding	4	8	1	15
Placing in vat	3	4	0	15
Cleaning seed	1	0	3	0
Taking out of vat	2	3	0	30
Wet-rolling and putting in drying room	1	16	2	20
Rolling for scutching	0	11	1	8
Striking for do.	0	7	4	47
Total	11	49	13	15
Scutching	4	0	6	16

ANALYSIS OF THE LIQUID OBTAINED IN WATT'S PATENT FLAX PROCESS.

At a meeting of the Chemico-Agricultural Society of Ulster, Dr. Hodges gave an analysis of the liquid obtained in Watt's patent flax process, and an account of the new process of preparing flax, patented by Messrs. Watt and Leadbetter, which he said offered the only practical method of economizing the matters which are separated from the flax plant in its preparation for the manufacturer, which had hitherto been proposed. The liquid which remains in the flax-vats employed in the new process possessed none of the disagreeable qualities of the ordinary steep-waters. It was free from smell, and in taste and color somewhat resembled an infusion of senna leaves. It was, in fact, a strong tea, containing, unchanged by fermentation or putrefaction, the soluble matters of the stem of the flax plant. It was at the present time advantageously used at Messrs. Leadbetter's works in feeding pigs. As it was desirable to ascertain the exact composition of this liquid and its nutritive value, he had procured a sample of it from the Bedford Street Works,

and had it submitted to chemical examination. The following were the results. One gallon evaporated to dryness gave :

Of organic matters	353·97 grains.
Of earthy and saline matters	161·49 "
Total amount of solid matter	515·46 "

The organic matter afforded, on analysis, 14·79 grains of nitrogen.

The earthy and saline matters were found to possess the following composition :—

COMPOSITION OF THE ASH OF THE STEEP-WATER OF FLAX.

	Per cent.	In a gallon.
Potash	27·17	44·63 grains.
Soda	3·18	5·12 "
Chloride of sodium	21·58	34·61 "
Lime	5·91	9·49 "
Magnesia	4·60	7·40 "
Oxide of iron	0·83	1·33 "
Sulphuric acid	15·64	25·11 "
Phosphoric acid	5·66	9·01 "
Carbonic acid	12·43	19·96 "
Silica	3·00	4·83 "
	100·00	161·49 "

Dr. Hodges stated that the flax liquid possessed considerable feeding qualities ; and Mr. Leadbetter, in reply to his enquiry, said that it had not been found to exhibit any purgative effect ; the pigs at his works received it mixed with turnips, and the husks of the flax, and were in a thriving fattening condition.

The vat liquid, Dr. Hodges observed, could be drawn off in a more concentrated form than the sample examined, and it would be easy for the manufacturer, by employing a hydrometer, to supply it of uniform strength.

COMPOSITION OF THE ASH OF FLAX SHOVES.

The shoves, or refuse woody matters which are separated in scutching flax, are at present employed in the steeping works as fuel. Dr. Hodges, in the course of the extended investigation of the flax plant, in which he was engaged, found that the ash which remains on the incineration of these matters had the following composition, and might, therefore, advantageously be economized for use as manure. 100 parts of ash afford :—

Potash	7·73
Soda	5·91
Chloride of sodium	1·78
Lime	20·15
Magnesia	5·46
Oxide of iron	5·60
Sulphuric acid	6·50
Phosphoric acid	10·43
Carbonic acid	20·10
Silica	16·00
	99·66

1000 lb. of shoves yield, on combustion, 19½ lb. of ash.

Mr. C. Fane, referring to the difficulties experienced in the fermentative processes, has given a graphic account of another method by which the fibre of

the flax, as no doubt of other plants, may easily be separated. Subjecting the wet fibres to heavy pressure is now adopted in most of the improved processes:

"At this juncture, an English gentleman, a Mr. Pownall, endeavoring to work out Mr. Claussen's idea of obtaining from flax a fibre that would spin on cotton machinery, made a most valuable discovery, as to the preparing flax for the common linen purposes, which was this, that if the flax straw, when taken out of the water in which it had been steeped and fermented, were instantly, *and before drying*, subjected to severe pressure, and a stream of cold water, the pressure would press out, and the water would wash away almost all the gluten remaining in the plant not removed by the fermentation.

It is impossible to over-estimate the value of this discovery. The grand difficulty in the management of the flax plant had always been the difficulty of hitting the happy mean between *over*-fermenting and *under*-fermenting the straw. If the straw were not fermented enough, the gluten was not sufficiently discharged, and then the woody parts of the plant stuck to the fibre so strongly, that nothing short of violent blows of the scutching instrument would remove it, and violent blows broke much of the fibre into short lengths, called tow, of little or no value. On the other hand, if the straw were fermented too much, then the gluten was, indeed, sufficiently discharged, and moderate blows sufficed to remove the woody matter; but in that case the fibre was weakened, and the blows, moderate as they were, again broke the fibre into tow. In either case the yield of valuable fibre was unsatisfactory, and the reed and quality deteriorated; and it was only in those cases where the exercise of the greatest care and judgment had enabled the steeper to trim most happily between fermenting *too much* and fermenting *too little*, that a satisfactory yield of fibre was obtained. Mr. Pownall's discovery at once triumphed over this hitherto almost insuperable difficulty, because it enabled him to stop short in the process of fermentation before he arrived at the *point of danger*, and yet remove the gluten even more effectually than excessive fermentation had previously done; from which there resulted the following advantages:—

"1st. The squeezing and washing so completely cleansed the fermented straw, that the objection to Schenck's hot-water system, arising from the putrid matter re-adhering to the straw, and flying off from the straw in dust in scutching; at once disappeared; and hence the mills erected for hot-water steeping resumed work, and no impediment now exists to steeping being carried on *all the year round.*

"2nd. Fermentation need never be carried beyond the perfectly safe point, and hence the fibre is not weakened.

"3rd. The woody matter is easily removed by moderate blows of the scutching instrument, because the sticky matter no longer impedes the operation, and hence the yield of fibre is much greater.

"4th. The fibre obtained is of a singularly soft and pliable character, and is much preferred by the spinner.

"5th. The subsequent process of bleaching is greatly facilitated, because it is the gluten which remains in the fibre which resists the action of bleaching ingredients, and under Mr. Pownall's process the gluten is effectually removed.

"The use is spreading more and more every day, and the results are universally acknowledged as most satisfactory. The process adds from £10 to £30 to the value of the ton of flax, according as the raw material is of inferior or superior quality; and the expense is the merest trifle."

These methods of preparing the fibre from flax stems which have been dried and stacked, afford considerable advantages, as the seed becomes more ripe, and the farmer can choose a leisure time for the preparation of his flax; or, better, he may confine his attention to growing the flax, and then send it for careful preparation to the factory or rettory.

STEEPING GREEN.*

With the above methods of separating flax which has been stacked, we may contrast that of steeping the stems when green, and which, when the

* The steeping of hemp when in a green state was strongly recommended by the Abbé Bralles; and the natives of India insist upon its being the best mode for *Sunn.*

quantity is small and can be worked up at once, would appear to be the most advantageous. M. Dufremont, cultivator à Hem (department du Nord), found that when the flax was used green, the steeping only required from six to seven days; and that six days' grassing gave the flax a finer color than could be obtained by any other means. It was dried and ready for scutching in three weeks; whereas the ordinary time in the district averaged from a year to a year and a half. He found also that it yielded 5 per cent. more fibre, which was worth fully 10 per cent. more money in the market. The flax was pulled before it was quite ripe, the seed bolls removed by rippling, and the straw immediately placed in the pits. The seed, however, was reduced about two francs per hectolitre in value.

The practice of steeping green is carried on to a large extent in the Waes District, in Belgium.

About Courtrai, in Belgium, the flax is steeped in the river Lys, which contains a remarkably pure and suitable water. In Flanders District (Pays de Waes) the flax is watered immediately after rippling in the manner now generally recommended, and the water used is allowed to become partially stagnant in the pools previous to the immersion of the plant.

It certainly is a strange fact, that the fermentation proceeds quite successfully in a *running stream* of fresh water; and it is evident, therefore, the process must go on in the juices and gummy matter, which connect the woody stem to the pure fibre of the plant, as the water itself has not time to become decomposed in passing through the bundles.

It is a common practice to run off the water from the steep-holes into the stream, and afterwards take out the flax. This system is contrary to all correct acknowledged principles of agricultural economy.

In the first place, the "flax water" so lost is excellent liquid manure, and its effects can be clearly traced on meadow land, where the plant has been spread for "grassing" immediately after removal from the pool. This liquid ought therefore to be preserved and carted in large barrels over the grass fields adjoining, or thrown over by means of hose, on Mr. Mechi's plan. In the next place, by running off the water, all the scum and dirt in the pool are allowed to settle among the flax plants, and the bundles are pressed against the sides and bottom of the hole, where they are sure to become soiled and dirtied, thus injuring the color and quality of the fibre. Lastly, the noxious fluid passing into the stream at a time when the river is at the lowest summer level, not only corrupts the water, and renders it unfit for domestic use, but poisons the fish therein—an offence punishable by law.

CHEMICAL PROCESSES.

The action of water and the production of fermentation may truly be considered chemical operations; but the term is usually applied to other processes, in which the action of soap, of acids, or of caustic or of carbonated alkalies, or of some salts, is employed to effect the separation of the fibres from each other, as well as from the cellular tissue and accompanying glutinous secretions. The natives of India have long been in the habit of bleaching their muslins by boiling them in a ley of carbonate of soda, and then washing them in a weak solution of citric acid, obtained from the juice of limes or of lemons. So in other parts they boil the bast of certain plants in a ley of wood-ashes, in order to facilitate the separation of the fibres. Some of the

chemical methods which have been invented in Europe are similar to these. In the "Jury Report" of Class IV., by Prof. E. Solly, for the Exhibition of 1851, we have an account of the old German process called "Molkenrost," sometimes used in preparing the finer sorts of flax. This was steeped for four or five days in a warm mixture of milk and water, and thus the desired degree of fermentation in the flax stems was produced. This is distinct from the more modern process in which linen was boiled by the Dutch in a weak alkaline ley, and subsequently treated with sour buttermilk, of which no doubt the lactic acid was useful in removing the alkali, as well as in dissolving some of the impurities of the fibre, and thus was nearly identical with the Indian process of bleaching. Subsequently, salt of sorrel (that is, an oxalate of potash, or the same salt which is so abundant in the leaves of the *gram* cicer arietinum), and sulphuric and muriatic acids were employed, but were found to be too costly. The careful experiments of Hermbstaedt, at the beginning of this century, threw much light on the chemical principles involved in, and on the influence of temperature on the separation of the fibre of flax.

These chemical processes have again attracted much attention, since the process patented by M. Claussen has shown how much the nature and appearance of fibre may be changed by the action of such agents. But this, like many other inventions, has many points of similarity with what had been done long before, without attracting much attention. Of it we have the following account in the above "Jury Report," p. 97:

"This process (patented August, 1850) consists essentially in boiling the cut and crushed stems of the flax, hemp, or other plant, in a dilute solution of caustic soda, containing about one two-thousandth part of alkali. The fibrous matter is then removed, and plunged into a bath of dilute sulphuric acid, consisting of one five-hundreth part of acid, in which it is boiled for about an hour. It is next transferred into a solution, containing about ten per cent. of carbonate of soda; and, lastly, when it has remained in the latter for an hour, it is plunged into a weak solution of sulphuric acid, consisting of one part of acid to two hundred or five hundred parts of water; in this it is left for about half-an-hour, and the process is completed. The effect of these several processes is to divide and split up the fibre in a most remarkable manner, so as completely to alter its character. Flax thus treated is converted into a substance very nearly resembling cotton."

The idea of modifying the fibre of flax and hemp, so as to convert it into a kind of cotton, is by no means new. In 1747, it was proposed to convert flax into cotton by boiling it in a solution of caustic potash, and subsequently washing it with soap. In 1775, considerable quantities of refuse flax and hemp were converted into flax cotton by Lady Moira, with the aid of T. B. Bailey, of Hope, near Manchester. It appears that the fibre was boiled in an alkaline ley, or a solution of kelp, containing carbonate of soda, and subsequently scoured. The result of this was, that "the fibres seem to be set at liberty from each other," after which it may be "carded on cotton cards." It appears that at this time "flax cotton" was made and sold at three pence a pound. Some of it was spun into cloth for gowns, and also for waistcoats; but her ladyship complains that the spinners were hostile to the discovery, for fear of its injuring the cotton trade, and the poor of the North of Ireland, to whom it was supposed it would be beneficial, were indifferent about the merits of the invention. Specimens of the flax cotton, and of the fabrics woven from it, are still preserved in the Museum of the Society of Arts.

Several attempts were subsequently made in Germany to convert, with the action of alkaline solutions, flax into a fibre resembling cotton, which could be used, either alone or together with cotton, in the manufacture of cotton

goods. But there, as in Ireland, the manufacturers probably set themselves against the introduction of flax cotton, and the work-people determined not to use the new material. The matter was subsequently investigated by Berthollet, by Gay-Lussac, and by Giobert, who employed alternately steepings in hot solutions of soap, alkali, and sulphuric and muriatic acid; and Berthollet observes that equally fine cotton is obtained from the commonest refuse tow as from the best flax (*vide* Jury Report, p. 98). More recently, in 1842, M. Rouchon, of l'Ecole Polytechnique, at Paris, has devised a method for preparing flax by means of immersion in a weak acid solution for a short period, and then placing it in a mass kept moist by occasional waterings. These are repeated daily until the desired effect is produced. The flax is kept tied up in small bundles, and a man and a boy could attend to two tons per day.

It is sometimes more than the farmer can manage himself, with all his other complicated affairs, to grow flax, and then to prepare it to a proper state to be sold to the spinner. For all these after-processes, too, he has often to educate a set of men and women to execute a series of nice and catching work, which they may have never seen done, and of which they have not the slightest idea.

The French and Belgian flax growers are relieved from the whole of the troublesome burden which the subsequent treatment of the crop entails. It is the custom there for persons called *liniers*, or flax factors, to buy the flax of the farmer as it stands in the field. After the weeding is completed, the farmer has nothing more to do with the crop, but to sell it and to cart it to the merchant after it is pulled. The linier pays for the pulling, thrashes the flax, and steeps it himself. The scutchers employed by the liniers are paid by him for their task at the rate of four *sous*, or two pence, the *kilo*, or about two pounds and a half weight; and in that way the flax is delivered either to private parties, or to flax mills, to be combed. It is the absence of the intermediate tradesman, who acts as a purchaser and preparer of flax, which is one main difficulty attending its cultivation in this country.

The flax growers of the principal countries of Europe declare that this plant produces seed which is less and less vigorous from year to year, unless the stock of grain is renewed by being brought from distant places of growth. The usual Flemish practice is to change the seed by a fresh importation from Riga every two years; others have thought that every three years would be sufficient to obtain a new supply from Russia; but it is found if a change be but made, it is by no means a matter of necessity that the seed should be of Russian growth. The French farmers, although preferring Riga seed, often make an interchange between village and village. In such cases they find their flax crops succeed to their perfect satisfaction.

Good flax seed should be smooth, slippery, and should sink in water; it should taste sweet, when chewed, and being broken should appear of a light yellowish-green color, and very oily. A good means of testing various samples of seed is to weigh equal *measured* quantities against each other. Experienced persons examine the seed by taking a handful of it, and letting it run out between their forefinger and thumb, in order to be able to observe it closely sidewise, and to be better able to judge of its plumpness and weight. Others moisten their forefinger, and dip it into the sample of seed, which sticks to it; they are thus able to examine each grain separately, and so form an opinion of its purity and goodness. Good seed should be very even in its quality, and free from mixture with the smaller seeds of weeds. Most growers prefer

to sow new seed, but, unlike hemp seed, linseed preserves its vitality for several years.

A writer thus describes the process of flax-weeding, from personal observation :

"Suppose that you had lost a single valuable pearl on the smooth-shaven grass plot before your door. To find it, a good plan would be to get half-a-dozen sharp-eyed women and children to go down on their knees side by side, as close together as they could conveniently work, and to make them creep steadily forward in a rank, like so many soldiers, searching as they advanced for the lost pearl, between every single blade of grass. This is exactly the way in which flax is weeded, docks, charlock and thistles being the objects of search, instead of pearls and rubies. While passing through Belgium in spring, I used to fancy that if a peasant, after retiring to rest, remembered that he had passed over one sprouting weed in his new-sown flax, he would be unable to sleep upon his mattress, and would get up in the middle of the night, to search for it by moonlight. To unprofessional eyes, the plant looks too delicate to bear the pressure of this inquisitive crowd; but its natural elasticity raises it again; and to help it, it is the custom for the weeders to advance *against* the wind, in order that the welcome breeze may aid the prostrate flax to hold up its head in the world once more."

During the blossoming period, in France and Belgium, the linier, or "flax man," will arrive, inspect the crop carefully, and make his bargain with the farmer to take it off his hands. The flax man undertakes all the subsequent manipulation of the flax, and the French farmer's anxieties cease exactly at the moment when, in consequence of his inexperience, the English flax-grower's only begin.

The signs of the fitness of the flax for pulling, are best learned by actual inspection and practice. Mr. Henderson states :—

"I have found the test recommended by Mr. Boss (a Dutchman), to ascertain the degree of ripeness that gives the best produce, with the finest fibre, perfect. It is this: Try the flax every day, when approaching ripeness, by cutting the *ripest* capsule, on an average stock, across (horizontally); and when the seeds have changed from the white, milky substance, which they first show, to a greenish color, pretty firm, then is the time to pull. The old prejudice in favor of much ripening is most injurious, even as regards quantity; and the usual test of the stalk stripping at the root and turning yellow, should not be depended upon. Where there is one man that pulls too green, five hundred over-ripen. I use the Dutch method of pulling, say, catching the flax close to the bolls; this allows the shortest of the flax to escape. With the next handful, the puller draws the short flax, and so keeps the long and the short each by itself, to be steeped in separate ponds. It is most essential to keep the flax even at the root end, and this cannot be done without time and care; but it *can* be done, and should always be done."

Without steeping, flax would be useless for textile purposes. By dew-retting the quality of the sample is seriously injured. The old-fashioned plan of steeping answers better on the whole than any other mode that has been discovered. But flax-steeping, it must be confessed, has many disadvantages attending it. In the first place, it is an offensive process. The smell which the ditches and ponds occasionally emit, is all but unbearable; so also is the odour of the flax when taken out of the water. The water wherein flax has been steeped, if let out at once into a stream, is fatal to the fish. Secondly, many farms, which are most suitable for flax-growing, are deficient in the quantity of water necessary for steeping. Here again we see the use of the liniers or flax-men.

It will thus be seen that several distinct conditions require to be combined, in order to adapt any one locality for the successful cultivation and preparation of flax, if it be necessary for the farmer himself to undertake the manipulation of the flax he grows; and they ought not to be overlooked by those

who are desirous of introducing a new and profitable branch of agriculture into their own neighbourhood. Attempts that are made without due consideration of each one of these conditions, will only lead to disappointment.

SCUTCHING.

This is done by the hand-scutch, or in the scutch-mill, after the flax has been passed through the break.

The scutching-board is an upright plank, fifty-one inches high, fourteen broad, and with a uniform thickness of three-quarters of an inch throughout, firmly fixed in a solid block of wood. At the height of thirty-seven and a half inches from the foot, is a horizontal slit, an inch and a half broad. With his left hand the scutcher introduces into the slit a handful of broken flax, so that it hangs down on the side of the scutching-board. With his right hand he scrapes and chops at the flax with a tool called a scutch. A leather strap, an inch in breadth, stretches between two low posts, at the height of nineteen inches from the ground, just before the workman's legs, at the lower part of the scutching-board, in order that he may not bark his shins while scutching the flax. The strap also, by its elasticity, causes the blow to rebound, and so aids the laborer in continuing his work. By these means, and by turning it about, the woody refuse is got rid of, and little else but the pure fibre remains.

The scutch itself is a tool whose form varies considerably in different countries. The most approved French scutch consists of three parts—the handle, made of light willow-wood; the table, made of the *heart* of walnut-tree; and the tail, made of the *branch* of walnut-tree. The latter portion is the great peculiarity of the implement, serving to give impetus to the blow, and also to steady the course of the scutch in its descent through the air, as the feather steadies the course of an arrow. The extreme length of the scutch, from the end of the handle to the tip of the tail, is twenty-four inches and a quarter. The greatest thickness of the tail at the upper part is a trifle more than an eighth of an inch. The table is considerably thinner. The upper part of the table is as thick as a halfpenny piece; the cutting edge or lower part as thick as a penny piece.

French scutchers, at two pence the *kilo* (short for *kilogramme*, and equal to 2,206 English pounds avoirdupois), can earn from eight pence to twenty pence a day, according to their skill, and the quality of the flax they have to do with.

DELIVERING THE SCUTCHED FLAX.

There are various forms in which flax is delivered to the spinner. They agree in one point, namely, in keeping the fibre in tightly bound handfuls, each of a fixed and definite weight, twisted in a convenient square form, according to the custom of the locality, and in uniting those handfuls into bales, containing a stipulated number, and, therefore, weighing a stipulated amount. In the Pas de Calais scutched flax is always delivered in the shape of two *kilo* handfuls (about five pounds and a half united), clapped together; and the purchaser may obtain these by the half-score, score, hundred or thousand.

One mode of making up a bale of flax is to begin by taking two handfuls of fibre, ready twisted into shape, and clapping them together, head and tail in an opposite direction, and going on in the same way, placing the handfuls alternately, to make them lie as close together as possible, till the determined

number of handfuls is packed; the whole is then bound with three cords passing round the middle, and not far from the two ends.

In packing flax, the producer should be careful to avoid putting samples of a different quality into the same bale; as, besides the possibility of its being looked upon as a species of fraud, it is always better to sell each quality separately for what it is worth, than to endeavor to obtain a mean or medium price for the whole, which will always turn out lower than the mean of the lowest and the highest prices. The British practice is to deliver flax in stones weight.

To obviate the objection which many land-owners have made to the flax crop, on account of its returning nothing to the land, and also to increase the quantity of fat cattle sent to market, Mr. Warnes conceived the idea of applying linseed to the maintenance and finishing off of the live stock usually kept on a farm. His object had reference more to the fattening than to the rearing of cattle, and to proving that double or even triple the usual number may be profitably returned, through the medium of linseed compound, box feeding and summer grazing. The system of feeding cattle in boxes had been long partially practised in various parts of the kingdom, and the growth of flax from time immemorial. The fattening of cattle with linseed was in full operation by the Hindoos fifteen hundred years ago; and in modern times in England, particularly in Norfolk, repeated attempts were made by the most expert graziers to establish the use of linseed. Summer feeding also, in stalls or houses, has been long practised on the continent. To Sir Edward Stracey's experiments in boiling grain, Mr. Warnes added the linseed infusion, and thus produced his "incomparable cattle compound." (See his book.)

The Société Linière of Brussels, in its printed recommendations, states:—

"Above all things, the rotation of crops must be scrupulously observed. If seven or eight years be allowed to elapse before again sowing flax in the same field, it is certain that there will be a good crop; but the less the interval between the two crops, the less is the second to be calculated on, either for quality or weight."

SCUTCHING MILLS.

In the scutching mills of the present day, instead of the arm of the man, a horizontal shaft is used, with wooden blades attached, revolving and acting on the flax vertically. The process of threshing by the mallet, in the hand operation, is performed now in the mills by passing the flax between a set of rollers, which bruise it so completely as to render much more easy the after-separation of the straw.

The Trustees of the Linen Manufacture, prior to A.D. 1828, directed great attention to improvements in the scutching process; and of late years Her Majesty's Government have shown a similar laudable anxiety to encourage the erection of superior mills.

In many parts of England and Ireland the want of flax-cleaning machinery, convenient to the farmsteads, is very much felt. The scutching is always rather an expensive operation, even in the North of Ireland; and in remote districts, where heavy carriage is required to a distant mill, the agriculturist is often much embarrassed. All large proprietors, or, where there are not such, the local farming associations, ought certainly to see that every district capable of growing flax is provided with a good scutching mill.

The Land Improvement Acts give power to the Commissioners of Public Works to lend money, on favorable terms, to needy proprietors, for the erec-

tion of scutch mills in Ireland. The estimated expense of the building, for containing about twelve stands for scutching, as sanctioned by the Office of Public Works, under Act 15 & 16 Vic. cap. 34, is £88 18*s.*, or in two stories, £95 6*s.* To this must be added the cost of the machinery, say a small water-wheel and gearing, with the shaft and blades attached, stocks and adjoining woodwork, and a set of rollers. The amount will vary very much, according to circumstances, and in proportion to the number of stands erected. A small mill with four stands would cost for this machinery about £60, while one with twelve stands would amount to £150, so that the relative costs would be approximately,

Small mill, complete	£104
Large do. do.	238

The figures are in sterling.

An improvement lately introduced and found of much service, is the adoption of stocks so arranged as to *spring* in the operation of scutching, and thus prevent the flax from being injured by too severe action from the blades.

By these spring-stocks, combined with flat, projecting spring-rings, or wheels, in the shaft, the action on the flax can be so nicely adjusted, as to apply extra work to the fibre requiring such, and to save from useless waste any that is easily cleaned.

Except in retteries like Schenck's or Watt's, the adoption of steam power for scutching is not suitable, for various reasons. The first outlay is too great, and the expense of working the engine too heavy.

The scutching of flax, including attendance of girls or boys, and carriage to and from the mill, costs about 1*d.* per lb. Now, the fibre is afterwards often sold for 6*d.* per lb.; so that the cleaning amounts to one-sixth, or 16⅔ per cent. of the marketable value! Of course, some flax will sell at a much higher rate than 6*d.* per lb.; but, taking even the extra price of 8*d.* per lb., the cost of scutching will be 12½ per cent.

Some very ingenious inventions have been patented in England, to facilitate and improve the cleaning operation. Among them may be mentioned that of Robert Plummer, Esq., of Newcastle-on-Tyne; McBride's machine, for the working of which no skilled workmen are needed; Wilson's machine, which is a medium between the hand-scutching and the ordinary flax mill; and the patent machine of the Messrs. Rowan, Belfast, Ireland, which may be suitable for districts where ordinary scutching mills are not to be found.

FLAX MARKETS, SPINNING, &c.

The operation of scutching renders the flax fit for market, and the farmer now acts with it as with any other crop. The principal markets for the Canadian farmer are, for fine qualities, Belfast, and for coarser, Dundee. There is also a home market for coarse qualities.

Flax fibre is injured by the owner keeping it too damp, in order to make it weigh well in the scale. Like all dodges, this is short-sighted policy, as the buyer generally detects, and offers a proportionately lower price. It is not, however, injurious to have a little damp.

The first process in the spinning mill is the rough sorting, so as to suit the different kinds of yarn to be made. The fine fibre is then passed to the cutting machine, which cuts off the ends, and leaves the prime centre part for the best yarn. The next process is "hackling," the object of which is to

clean the fibre further, by combing it, as it were. A large quantity of refuse called "tow" is taken off here. After being hackled, the flax goes to the sorting and dressing room, where it is arranged for the next process, called "drawing;" thence to the roving-frame, where it is wound on large spools or bobbins, and made ready for the spinning.

Flax can be spun dry, like cotton; but being a much stronger and firmer fibre, much less can be taken out of it in that way than when hot water is used. Probably fibre which, when spun dry, would produce only 20 leas yarn, would, when wetted, spin up to 70 leas or more, and thus prove much more remunerative.

The "spinning-jenny" is so well-known that no description is required, so we will follow the small spools of yarn into the reeling room. Here they are unwound and measured on the reels: 60,000 yards make a bundle, which is sub-divided into hanks and cuts.

Each hank contains 12 cuts or leas, and each cut 300 yards; consequently 16⅔ hanks are equal to a bundle. These bundles are tied up in bunches of three, six, nine or twelve, according to the fineness and quality. After being carefully dried by steam in lofts, the yarn is ready for sale.

.The finest spun for commercial purposes is about 340 leas of 300 yards each to 1 lb. weight. The coarsest spun out of pure flax is about 20 leas to the pound.

The "tow" thrown off in the hackling process is not allowed to go to waste: it is collected in bags, shaken out by a special machine, and then undergoes a most elaborate "carding" or combing process, ending in being reduced to a large ribbon, ready for "drawing" and spinning, as already described. This operation is very ingenious, and is a triumph of mechanical skill.

The yarn from tow is used for making coarse articles; it has a peculiar softness, which renders it very suitable for towelling, being pleasant to the skin, and an excellent absorber of moisture.

Some spinners sell all the yarn they produce in the home market; others have a large export demand. Some make the yarns into linens, bleach them, and become regular linen merchants; others have power-loom factories, and sell the linens in the brown state, after being manufactured on the spot.

People talk of mills by the number of spindles they contain. Less than 4,000 will not pay, and some have as many as 20,000. One enormous single mill (York-street Flax Spinning Company, Belfast) has nearly 30,000 spindles; value, with buildings, say £90,000.

THREAD.

Closely allied to yarn is thread. The fibre for heavy, strong thread-yarn, used by shoemakers, is spun with a very long reach, and without going through water. The only damp imparted to it is from a roller it passes over, which is kept moist with cold water. This thread-yarn does not receive any other twisting by machinery; the shoemakers do this for themselves by hand.

From the ordinary hot water spinning frame, the yarn for tailor's thread proceeds to the twisting frame.

Besides the strong thread-yarn for shoemakers, a very substantial article is made for fishing-nets, called "gilling thread." Large quantities of this are used for the Newfoundland fisheries. Almost all threads get at least one boil

in soda-ley, to purify them. The shoemaker's and the gilling-net threads are put up in nice little balls, of two ounces each, or one ounce, as may be ordered by the purchaser. Owing to the dearness of flax, a good deal of Italian hemp has been used in making coarse yarns for thread.

One of the largest firms in this branch of trade, is that of the Messrs. Barbour & Sons, of Lisburn, Ireland.

The flax and hemp fibres have so much tenacity, combined with pliability, that wherever great strength is required they have no successful competitors. In fine-bleached sewing thread, however, cotton has very much interfered with flax of late, as the manufacture of cotton thread has been immensely improved; and the white colour so easily obtained in that fibre is with much difficulty approached in linen thread.

WEAVING.

Eighty years ago, Dr. Cartwright applied the principle of power to cotton weaving; and since then, by a succession of improvements, the power-loom has attained great perfection.

Some years ago it was thought almost impossible to manage flax yarn in a power-loom; but gradually, by perseverance and skill, the difficulties have been removed in a very great degree; and excellent goods, 10°° to 16°° in fineness, are now turned out, equal, if not superior, to the production of the hand-loom. The only point that appears yet in favor of the hand-loom is the selvage or edge in heavy goods; yet even here the improvements of mechanism go on steadily, and are sure to triumph in the end.

There are two ways of preparing yarn for weaving by power. The first plan is to send it to the factory direct, without any special preparation; the other is to cleanse it by boiling, as is done for the hand-looms. The second treatment is necessary in first-class heavy bleaching goods, as the green, unprepared yarn reduces very much in the bleaching process.

The warp yarns in the warping machines are passed through a paste made from Carrigeen moss,* or some such substance, and afterwards nicely brushed: this prevents the weft catching on the warp, and permits it to slip along more easily.

The warp is again restored to a roller, and then is ready for the power-loom.

Meantime the weft yarn received from the mill has been removed by machinery from the spinning bobbins, and is forwarded in this state to the girl in charge of the loom. She places the yarn in the shuttle, and starts the loom. Perhaps the weft yarn breaks after crossing two or three times; and if the girl is not watching, you think the loom will go on trying to weave. No such thing; though not endowed with animal life, it shows in its clever mechanism the intelligence of man.

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* This moss is, strictly speaking, a kind of sea-weed or algae; its botonical name is *chondrus orispus*. It is collected in considerable quantities on the coasts of Ireland. It is first bleached and dried by exposure to the atmosphere, and in this state is sold. When boiled, it forms a highly gelatinous substance, like isinglass or Iceland moss. If linen power-looms continue to increase in numbers, as they are doing at present, several thousand pounds worth of this algae will be required each year for the yarn dressing described. We sometimes hear of the poor Irish peasants devouring sea-weed, to mitigate the pangs of hunger; but it is not perhaps generally known that this Carrigeen, boiled with a little milk, makes a most nourishing jelly, and when nicely prepared, forms a *blancmange* fit for any table.

A weaver, named Bullick, invented a peculiar kind of catch-wheel, with a lever ending in a fork, which is arranged so that the weft yarn must gently touch it in passing. If it fail to do so, the catch-wheel stops the loom!

It is interesting to watch the various motions in the machinery of a power-loom;—the roller gently pulling on the cloth as it is made; the sleigh driving tight home the weft which the little shuttle slips in between the divided yarns of the warp; the headles raising the alternate sets of yarn to receive the next shot of weft; the striker, which represents the weaver's arm, at regular intervals propelling the shuttle by a blow across to the other side of the loom—a regular game of battledoor and shuttlecock. All these actions going on with each loom, and hundreds of looms in the same building, causing a din resembling the crash of battle. In this peaceful strife, however, no blood is shed, but food and raiment are earned by willing hands for themselves and the little hungry mouths at home.

The cost of a power-loom for cotton is £10; that for linen is about £14. To this sum has to be added the driving or motive power, and the cost of the buildings, each nearly equal amounts, making the total cost of a good sized factory about £42 sterling a loom.

The weaving of damasks is still carried on in the Jacquard loom.* The series of cards, perforated with numerous apertures, are the means of giving the pattern to the cloth. Some expensively mounted looms will cost as high as £200. The arranging of patterns and the placing of the cards requires considerable skill, and is almost a special business of itself.

Linen cloth is regulated as to fineness by different scales. The ordinary scale is 40 inches, and according to the number of threads used in that space the fineness is determined. However, by one of those curious perversities so common in trade names, the linen is called, not by the actual number of threads in the 40 inches, but by the number of bars or reeds through which the warp passes. Now, the warp threads do not go through these reeds singly, but two through each opening; consequently a web called a 10°° is in reality a 20°°; that is, there are 2,000 yarns in 40 inches wide of the cloth before it receives the weft.

In the weaving, the width of 40 inches is reduced to 38, and in the bleaching process this is generally again reduced to 36.

Let us, for example, take a piece of so-called yard-wide brown cloth, styled a 15°°, and it will count 15 threads of warp under what is called a 38-inch glass. Let us count how many threads are in one inch; we will find them amount, as near as possible, to 70; the web measures 38 inches wide, so $79 \times 38 = 3{,}002$. The total threads in the width is just 3,000, but the reed used has only half as many openings, and the cloth being called after the reed is styled a 15°°.

The correct way to reckon fineness would be by the number of threads in the warp of the cloth; but by custom it is the fineness of the reed that is adopted, this being half the number of threads, as already explained; the glass, instead of being 1-100th part of 40 inches, is made 1-200th part of 40 inches. For example, take a web with 2,000 threads in the 40 inches; the

* The monument erected by the Chamber of Commerce, of Lyons, in the cemetery of Oullins, near that city, over the grave of Jacquard, the inventor of the loom for weaving figured silk, consists of a white marble tomb, raised several steps above the level of the ground, and sculptured with a bas-relief representing the City of Lyons crowning Jacquard's bust.

reed has only 1,000 openings, and the web is styled a 10°°. A magnifying glass with an aperture below must, in order to be a 40-inch glass, be had to count 10, *i. e.*, 1-200th part of 40 inches, which is 0.20, or 20-100ths, or 1-5th of an inch.

A 38-inch glass is 0.19, or 19-100ths of an inch; a 37-inch glass is 0.185, or 18½-100ths of an inch; a 36-inch glass is 0.18, or 18-100ths of an inch.

With this information, any one can easily test for himself the accuracy of the counting glasses offered for sale.

The technical names given by manufacturers to the warp reeds are, 40 yarns, or 20 splits, equal to 1 beare; 5 beares make one set, or 100 (splits).*

BLEACHING.

Bleaching is defined by Dr. Ure to be "the chemical art by which the various articles used for clothing are deprived of their natural colour, and are made white." Many years ago, Mr. Lee proposed several alterations in the existing system, and there was one improvement he brought forward that is at present in use, namely, the extensive use of soap in bleaching. The oil in the soap restores to the fibre much of the tenacity and softness that the continued boiling and chemical operations it undergoes have a tendency more or less to reduce.

Mr. W. Higgins, M. R. I. A., sixty years ago, recommended sulphuret of lime as a substitute for potash. Lately, hyposulphite of soda has been suggested as a safeguard after using chlorine.

The following is a brief outline of the existing system in an Irish bleach-green. The boiling is conducted in large iron vessels, with lids secured down tightly, so as to retain all the steam, and thus prevent loss of heat, air, and reduction in the amount of liquid, which must occur with open vessels.

The liquid used in the boiling process is alkaline ley, generally prepared now from soda ash; in old times, barilla and potash were mixed.

After boiling, the linens are washed and exposed to the action of the atmosphere on the grass for two or three days, according to the season and weather.

These processes are frequently repeated, and go on till the goods are half white. The straw of the flax, which cannot be perfectly extracted in the scutching and cleaning, now shows greatly, and demands a new application.

This consists of giving a bath of water, having in solution chloride of soda, or potash, or lime. The former is the safest, and now generally adopted.

The action of sulphuric acid, reduced to two or three of Twaddel's alkalimeter, is also beneficial, though it is a question whether this should be used after the chloride, as in old times, or before it.

The breaking and whitening of the straw or sprit is greatly facilitated by what is called "rubbing;" this is, in fact, an imitation of hand-washing by machinery, and, with plenty of soap, is an excellent part of the bleaching process, contributing to increase rather than diminish the strength of the fibre.

When the linen is quite white, it is starched, and afterwards dried on steam-heated rollers; it is then ready for what is called the "finishing" process, given to it by machinery called "beetles." The whole time required for the bleaching is from four to seven weeks, according to the season and the weight of the fabric.

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* See Charley on Flax.

The introduction of soda ash, and the centralising of business in large concerns, has wonderfully cheapened the cost of bleaching. Not very many years ago, a piece of light yard-wide linen would cost the merchant 3*d.* per yard to bleach, which is now done for 1¼*d.*, and in one-third the time.

It cannot be said that the apparently high price of linen, as compared with cotton, is attributable to the bleaching expense. In order to show the difference between the bleaching of cottons and that of linens, the following table of operations is extracted from a memorandum book by a working man:

COTTONS.

		Minutes.	Days.
1. Lime boil for twelve hours	wash	40	1
2. Sour in muriatic acid for ten hours	"	40	1
3. Boil in lye for eight hours, 2 degs	"	20	1
4. Boil in lye for eight hours, 1½ degs	"	30	1
5. Dip for twelve hours in alkaline, 40 to 1 strength.	"	30	1
6. Sour for twelve hours in vitriol, 2 degs	"	35	1
			6

If the above process does not make them white, give another light dip, and sour.

LINENS.

For bleaching one parcel of light linens, say 150 double pieces:

		Minutes.	Days.
1. Steep for twenty-four hours	wash	15	2
2. Boil for seven hours in lye and rosin, 2½ degs.	"	15	1
3. Boil for nine hours in lye, 2½ degs.	"	30	1
4. Grass for three days	"		3
5. Boil for ten hours in lye, 3 degs	"	30	1
6. Grass for three days	"		3
7. Boil for eight hours in lye, 3 degs	"	30	1
8. Grass for three days	"		3
9. Rough sour for ten hours in vitriol, 2 degs	"	40	1
10. Scald for four hours in weak lye	"	30	1
11. Grass for two days	"		2
12. Dip for ten hours in alkaline, 40 to 1 strength	"	30	1
13. Sour for twelve hours in vitriol, 1½ degrees	"	45	1
14. Scald for four hours in lye and soap	"	20	1
15. Rub with brown soap	"	35	1
16. Grass for two days	"		2
17. Dip for ten hours in alkaline, 30 to 1 strength	"	20	1
18. Sour for twelve hours in vitriol, 1 deg.	"	45	1
19. Scald for three hours in soap and lye	"	30	1
20. Dip for ten hours in alkaline, 45 to 1 strength	"	20	1
21. Sour for twelve hours in vitriol. 1 deg	"	45	1
22. Rub with soap	"	20	1
Time taken			31

The goods should now be white and ready for beetling.

Ireland possesses the best climate in the world for linen bleaching; and it is this local advantage—this gift of nature—that has gradually given to her, and secures to her still, so high a position in this branch of commercial industry.

A large quantity of low-priced linen is exported brown, as received from the looms; another class is slightly tinged yellow by steeping in dilute muriate of tin and catechu, and then finished or glazed by the beetling process already described. The former are technically called "rough browns," and are used for blouses. The latter, styled "hollands," are much used for window blinds. Drab color is produced by using fustic, after what is called

the iron liquor, *i. e.*, acetate of iron. For black this acetate is used diluted, to stand 5° of Twaddel's hydrometer, then dry the cloth, wash and plunge in a logwood bath. For slate color, divi divi, or shellac, after the iron liquor.

DYEING AND PRINTING.

The dyeing or printing of linens is, to use the words of Dr. Ure. "A Chemical Art." A very important part of the process is the correct application of the mordants, or, as he explains, "the substances which are used, previously applied to piece goods, in order that they may afterwards take a required tinge or dye." Of course, if the mordants be applied over the whole cloth, and it afterwards is plunged into the dye, an even color will result; while, if the mordant is only applied to portions of the cloth, an uneven color or pattern will come out.

The latter operation is called "printing;" the former simply "dyeing." The printing of cotton cloth or calico has been so well described by Dr. Ure and other eminent chemists, that it is needless to enter into any general account of this chemical art.

There is one advantage the linen fabric has over cotton that it is worth while to mention, for the information of the gentler sex, some of whom have met with such frightful accidents from their muslin dresses taking fire. The flax fabric is safe, comparatively, being very slow to ignite.

Yet, it is singular to find that nearly all the linens printed in Ireland are for the foreign trade, scarcely a piece for home consumption. On the European continent, in the United States, in Mexico and the West Indies, these goods are greatly in favor.

DIFFERENT METHODS OF PREPARING FLAX FOR MARKET.

In Belgium, as already stated, there are two methods of preparing flax for market. The one is practised in the West Flanders and in the French Flanders, and is called the Courtrai system, or white steeping and bleaching. This system might be well adapted to this country, as it can be carried on on a large scale much better than the Blue system But it requires more capital on the part of the manufacturer, as the flax is not ready for market before it is two years old; it can only be practised, however, where there is the convenience of good running water.

The Blue system is practised in different parts of Belgium, there being no difficulty under this method of finding steeping-places. The flax is manufactured and brought to market the same year that it is grown.

The following statement shows the average value, in sterling, of flax in Belgium, in its green state, and also when manufactured for market:

VALUE OF AN ACRE OF FLAX IN THE BLUE DISTRICTS, IN ITS GREEN STATE, WHEN READY TO PULL.

	£.	s.	d.	£.	s.	d.
One English acre, fair quality	12	0	0			
Seed	2	0	0			
				14	0	0

EXPENSES OF GROWING AN ACRE OF FLAX IN THE BLUE DISTRICTS.

	£	s.	d.			
Rent and taxes of one acre	1	15	0			
Ploughing and sowing	1	0	0			
Seed	1	5	0			
Manure	1	10	0			
Weeding	0	10	0			
				6	0	0
Leaving profit to the grower				£8	0	0

VALUE OF AN ACRE OF FLAX IN THE WEST FLANDERS AND ENVIRONS OF TOURNAY IN ITS GREEN STATE, WHEN READY FOR PULLING.

	£	s.	d.	£	s.	d.
One acre of good quality	16	0	0			
Seed of one acre of good quality	1	15	0			
				17	15	0

EXPENSES OF GROWING AN ACRE OF FLAX IN THE WEST FLANDERS AND ENVIRONS OF TOURNAY.

	£	s.	d.	£	s.	d.
Rent and Taxes	1	15	0			
Ploughing and Sowing	1	10	0			
Manure	2	0	0			
Seed	1	15	0			
Weeding	0	15	0			
				7	15	0
Leaving profit to the grower				£10	0	0

ON THE BLUE SYSTEM.

VALUE OF AN ACRE OF FLAX WHEN MANUFACTURED READY FOR MARKET, I.E., WHEN SCUTCHED.

	£	s.	d.	£	s.	d.
7 cwt. of flax, at 80s. per cwt.	28	0	0			
2 cwt. of tow, at 10s. per cwt.	1	0	0			
				29	0	0

EXPENSES OF MANUFACTURING AN ACRE OF FLAX READY FOR MARKET.

	£.	s.	d.	£	s.	d.
Price of one acre	12	0	0			
Pulling	0	14	0			
Rippling	0	15	0			
Steeping and Carting	0	16	0			
Spreading	0	15	0			
Turning	0	5	0			
Scutching 7 cwt. at 12s.	4	4	0			
				19	9	0
Profit to the manufacturer				£9	11	0

ON THE COURTRAI SYSTEM—SUMMER BLEACHING.

VALUE OF AN ACRE OF FLAX WHEN MANUFACTURED READY FOR MARKET (SCUTCHED).

	£	s.	d.	£	s.	d.
7 cwt. of flax at £6 per cwt	42	0	0			
2 cwt. of fine tow, at 15s. per cwt.	1	10	0			
				43	10	0

EXPENSES OF MANUFACTURING AN ACRE OF FLAX READY FOR MARKET.

	£	s.	d.	£	s.	d.
Cost price of one acre	16	0	0			
Pulling	0	15	0			
Stacking	0	5	0			
Tying-up and Stacking	0	12	0			
Taking off the seed	0	8	0			
Steeping, capping, &c.	1	10	0			
Turning caps, &c.	0	5	0			
Tying-up, &c.	0	5	0			
Bleaching and turning	1	15	0			
Tying up and carting home	1	0	0			
Scutching 7 cwt. at 20s.	7	0	0			
				29	15	0
Profit to the manufacturer				£13	15	0

Directions for the proper management of the Flax crop; originally compiled by the Committee of the late Royal Flax Improvement Society. Revised by the Special Committee of the North-East Agricultural Association of Ireland, for promoting the growth of Flax, Belfast, March, 1860.

SOIL AND ROTATION.

By attention and careful cultivation, good flax may be grown on various soils; but some are much better adapted for it than others. The best is a sound, dry, deep loam. It is almost essential that the land should be properly drained and subsoiled; as, when it is long saturated with either underground or surface water, good flax need not be expected.

The best rotation is to grow after wheat, on average soils; but in poor soils, where wheat does not succeed, it is often better to grow it after potatoes. Flax should on no account be grown oftener than once in five years, and once in seven is considered safer.

Any departure from this system of rotation is likely to cause loss and disappointment.

PREPARATION OF THE SOIL.

One of the points of the greatest importance in the culture of flax, is by thorough draining, and by careful and repeated cleansing of the land from weeds, to place it in the finest, deepest, and cleanest state. This will make room for the roots to penetrate, which they will often do to a depth equal to one-half the length of the stem above ground.

After wheat, one ploughing may be sufficient, on light, friable loam, but two are better; and on stiff soils, three are advisable—one immediately after harvest, across the ridges, and two in spring, so as to be ready for sowing in the first or second week of April. Much will, of course, depend on the nature of the soil, and the knowledge and experience of the farmer. The land should be so drained and subsoiled that it can be sown in flats, which will give more even and much better crops. Subsoiling should not be done at a less interval than two years prior to the flax crops. This gives the land time to consolidate. But, until the system of thorough draining be general, it will be advisable, after oats, to plough early in autumn, to the depth of six or eight inches. Throw the land into ridges, that it may receive the frost and air; and make surface drains to carry off the rains of winter. Plough again in spring, three or four inches deep, so as to preserve the winter surface for the roots of the flax. The spring ploughing should be given some time before sowing, to allow any seeds of weeds in the land to vegetate, and the harrowing in of the flax seed will kill them, and save a great deal of after weeding. Following the last harrowing, it is necessary to roll, to give an even surface, and consolidate the land, breaking up this again with a short-toothed or seed-harrow before sowing, which should be up and down, not across the ridges, or anglewise. These operations can be varied by any skilful farmer, to suit peculiar soils, or extraordinary seasons. The object is to have clean, fine soil, as like as possible to what a garden soil should be.

Rotation recommended by a gentleman of considerable experience :—

AVERAGE SOILS.	POOR SOILS.
1. Grass.	1. Grass.
2. Oats.	2. Oats.
3. Potatoes or Turnips.	3. Potatoes.
4. Wheat.	4. Flax.
5. Flax on half.	5. Hay.
6. Clover Hay.	

SOWING.

The seed best adapted for the generality of soils is Riga, although Dutch has been used in many districts of country for a series of years with perfect success, and generally produces a finer fibre, but not so heavy a crop as Riga. In buying seed, select it plump, shining, and heavy, and of the best brands, from a respectable merchant. Sift it clear of all the seeds of weeds, which will save a great deal of after trouble when the crop is growing. This may be done by farmers, and through a wire sieve, twelve bars to the inch. Home-saved seed has produced excellent crops, yet it will be best, in most cases, to use the seed which is saved at home for feeding, or to sell it for the oil mills. The proportion of seed may be stated at one Riga barrel, or three and a-half imperial bushels to the Irish or plantation acre; and so on, in proportion to the Scotch or Cunningham, and the English or statute acre. It is better to sow rather too thick than too thin; as, with thick sowing, the stem grows tall and straight, with only one or two seed capsules at the top; and the fibre is found greatly superior, in fineness and length, to that produced from thin sown flax, which grows coarse and branches out, producing much seed, but a very inferior quality of fibre. The ground being pulverised, and well cleaned, roll and sow. If it has been laid off without ridges, it should be marked off in divisions, eight to ten feet broad, in order to give an equable supply of seed. After sowing, cover it with a seed harrow, going twice over it—once up and down, and once across or anglewise, as this makes it more equally spread, and avoids the small drills made by the teeth of the harrow. Finish with the roller, which will leave the seed covered about an inch—the proper depth. The ridges should be very little raised in the centre, when the ground is ready for the seed, otherwise the crop will not ripen evenly; and when land is properly drained, there should be no ridges. A stolen crop of rape or winter vetches, or of turnips of the Stone or Norfolk globe variety may be taken after the flax is pulled. Rolling the ground after sowing is very advisable, care being taken not to roll when the ground is so wet that the earth adheres to the roller. If the crop be grown oftener than the regular rotation mentioned, then manure should be tried.

WEEDING.

If care has been paid to cleaning the seed and the soil, few weeds will appear; but if there be any, they must be carefully pulled. It is done in Belgium by women and children, who, with coarse cloths round their knees, creep along on all-fours. This injures the young plant less than walking over it, which, if done, should be by persons whose shoes are not filled with nails. They should work also facing the wind, so that the plants laid flat by the pressure may be blown up again, or thus be assisted to regain their upright position. The tender plant, pressed one way, soon recovers; but, if twisted or flattened by careless weeders, it seldom rises again. The weeding should be done before the flax exceeds six inches in height.

PULLING.

The time when flax should be pulled is a point of much nicety to determine. The fibre is in the best state before the seed is quite ripe. If pulled too soon, although the fibre is fine, the great waste in scutching and hackling renders it unprofitable; and if pulled too late, the additional weight does not compensate for the coarseness of the fibre. It may be stated, that the best time for pulling is, when the seeds are beginning to change from a green to a pale

brown color, and the stalk to become yellow, for about two-thirds of its height from the ground. When any of the crop is lying and suffering from wet, it should be pulled as soon as possible, and kept by itself. So long as the ground is undrained, and imperfectly levelled before sowing, the flax will be found of different lengths. In such cases, pull each length separately, and steep in separate pools, or keep it separate in the same pool. When there is much second growth, the flax should be caught by the puller just underneath the bolls, which will leave the short stalks behind. If the latter be few, it is best not to pull them at all, as the loss from mixture and discoloration by weeds would counterbalance the profit. If the ground has been thoroughly drained, and laid out evenly, the flax will likely be all of the same length. It is most essential to take time and care to keep the flax even, like a brush, at the root ends. This increases the value to the spinner, and, of course, to the grower, who will be amply repaid by an additional price for his extra trouble. Let the handfuls of pulled flax be laid across each other diagonally, to be ready for the

RIPPLING,

Which should be carried on at the same time, and in the same field with the pulling. If the only advantage to be derived from rippling was the comparative ease with which rippled flax is handled, the practice ought always to be adopted; but, besides this, the seed is a most valuable part of the crop, being worth, if sold for the oil-mill, £3 per acre, and if used for feeding stock of all kinds, at least £4 per acre. The apparatus is very simple. The ripple consists of a row of iron teeth screwed into a block of wood. This can be made by any handy blacksmith.* It is to be taken to the field, where the flax is being pulled, and screwed down to the centre of a nine-feet plank, resting on two stools. The ripplers may either stand or sit astride at opposite ends. They should be at such a distance from the comb as to permit of their striking it properly and alternately. A winnowing sheet must be placed under them, to receive the bolls as they are rippled off; and then the ripplers are ready to receive the flax just pulled, the handfuls being placed diagonally, and bound up in a sheaf. The sheaf is laid down at the right hand of the rippler and untied. He takes a handful with one hand, about six inches from the root, and a little nearer the top with the other. He spreads the top of the handful like a fan, draws the one half of it through the comb, and the other half past the side; and, by a half-turn of the wrist, the same operation is repeated with the rest of the bunch. Some, however, prefer rippling without turning the hand, giving the flax one or two pulls through, according to the quantity of bolls. The flax can often be rippled without being passed more than once through the comb. He then lays the handfuls down at his left side, *each handful* crossing the other, when the sheaf should be carefully tied up and removed. The object of crossing the handfuls so carefully, after rippling, when tying up the beets for the steep, is that they will part freely from each other when they are taken to spread out on the grass, and not interlock and be put out of their even order, as would otherwise be the case. If the weather be dry, the bolls should be kept in the field, spread on winnow-cloths, or other contrivance for drying; and if

* The best ripples are made of half-inch square rods of iron, placed with the angles of iron next the ripplers, 3-16ths of an inch asunder at the bottom, half-an-inch at the top, and 18 inches long, to allow a sufficient spring, and save much breaking of flax. The points should begin to taper three inches from the top.

turned from time to time, they will win. Passing the bolls first through a coarse riddle, and afterwards through fanners, to remove straw and leaves, will facilitate the drying. If the weather be moist, they should be taken indoors, and spread out thinly and evenly on a barn floor, or on a loft, leaving windows and doors open, to allow a thorough current of air, and turned twice a day. By the above plan of slow drying, the seed has time to imbibe all the juices that remain in the husk, and to become perfectly ripe. In fine seasons the bolls should always be dried in the open air, the seed threshed out, and the heaviest and plumpest used for sowing or crushing. The light seeds and chaff form most wholesome and nutritious feeding for cattle. Flax ought not to be allowed (under this method) to stand in the field, if possible, even the second day; it should be rippled as soon as pulled, and carried to the water as soon as possible, that it may not harden.

WATERING.

This process requires the greatest care and attention. River water is the best. If spring water has to be used, let the pond be filled some weeks, if possible, before the flax is put in, that the sun and air may soften the water. That containing iron, or other mineral substances, should never be used. If river water can be had, it need not be let into the pond sooner than the day before the flax is to be steeped. The best size of a steep pool is 12 to 18 feet broad, and three and a quarter to four feet deep. Place the flax loosely in the pool, in one layer, somewhat sloped, and in regular rows, with the root end underneath; the tie of each row of sheaves to reach the root of the previous one; cover with rushes, or straw, or other material, with stones laid on it, so as to keep the flax just under the water, and as the fermentation proceeds, additional weight should be laid on—to be removed as soon as the fermentation ceases, so as not to sink the flax too much in the pool. Thus covered it never sinks to the bottom, nor is affected by air or light. A small stream of water, allowed to run through a pool, has been found to improve its colour. In this case, if the pools are in a line, the stream should be conducted along the one side, and run into each pool separately, and the water of each pool run off, along the oppotite side, in a similar manner. It will be sufficiently steeped, in an average time, from eight to fourteen days, according to the heat of the weather and the nature of the water. Every grower should learn to know when the flax has had enough of the water, as a few hours too much may injure it. It is, however, much more frequently *under*-watered than *over*-watered. The best test is the following:—Try some stalks of average thickness, by breaking the *shove*, or woody part, in two places, about six or eight inches apart, at the middle of the stalk; catch the broken bit of wood, and if it *will pull freely out, downwards, for that length, without breaking or tearing the fibre, and with none of the fibre adhering to it*, it is ready to take out. Make this trial every six hours after fermentation subsides, for sometimes the change is rapid. Never lift the flax roughly from the pool, with forks or grapes, but have it carefully handed out of the flax drain by men standing in the water. It is advantageous to let the flax drain twelve to twenty-four hours after being taken from the pool, by placing the bundles on their root ends, close together, or on the flat, with the slope; but the heaps should not be too large, otherwise the flax will be injured by heating.

The flax water can be either used as liquid manure for meadows, or kept n the p ool till the first flood; it should not be run off into the river when

the water is very low, as the odour is very unpleasant; and the water thus impregnated is poisonous to fish, and contrary to law.—See Fisheries Act, cap. 62 sec. 36.

SPREADING.

Select, when possible, clean, short, pasture-ground for this operation; and mow down and remove any weeds that rise above the surface of the sward. Lay the flax evenly on the grass and spread thin and very equally. If the directions under the head of rippling have been attended to, the handfuls will come readily asunder without entangling. Turn it two or three times while on the grass (with a rod about eight feet in length, and an inch and a half in diameter), that it may not become of different shades by the unequal action of the sun, which is often the case through inattention to this point. Turn it, when there is a prospect of rain, that the flax may be beaten down a little, and thus prevented from being blown away.

LIFTING.

Six to eight days, if the weather be showery, or ten to twelve, if it be dry, should be sufficient on the grass. A good test of its being ready to lift, is to rub a few stalks from the top to the bottom; and when the wood breaks easily, and separates from the fibre, leaving it sound, it has had enough of the grass. Also, when a large proportion of the stalks are perceived to form a *bow and string*, from the fibre contracting and separating from the woody stalk. But the most certain way is to prove a small quantity with the hand-break or in a flax-mill. In lifting, keep the lengths straight and the ends even, otherwise great loss will occur in the rolling and scutching. Let it be set up to dry for a few hours, and afterwards tie it up in small bundles; and, if not taken soon to be scutched, it will be much improved by being put up in small stacks, loosely built, with stones or brambles in the bottom to keep it dry and allow a free circulation of air. Stacks built on pillars would be the best.

DRYING,

By fire, *is always most pernicious.* If properly steeped and grassed, no such drying is necessary; but to make it ready for breaking and scutching, exposure to the sun is sufficient. In some districts it is put to dry *on kilns* in a damp state, and is absolutely burned before it is dry; and the rich oily appearance of the flax is always greatly impaired.

BREAKING AND SCUTCHING.

If done by hand, should be on the Belgian system, which is less wasteful than that practised in Ireland. If by milling, the farmer will do well to select those mills in which the improved machinery has been introduced.

THE COURTRAI SYSTEM.

This mode of preparation requires to be very carefully executed, as inattention will reduce the value of the straw, and yield inferior fibre. When made up for drying in large sheaves, the straw is much injured, the outside stalks being much discolored by the heat of the sun before the inside of the sheaf is dry. The flax-stems should be put together in bunches, about one-half larger than a man can grasp in one hand, spread a little, and laid on the ground in rows after each puller; the bunches laid with tops and roots alternately, which prevents the seed-bolls from sticking to each other in lifting. It

should be stooked as soon after pulling as possible, and never allowed to remain over night unstooked, except in settled weather. The stooking should go on at the same time as the pulling, as, if flax is allowed to get rain while on the ground, its color is injured. A well-trained stooker will put up the produce of a statute acre or more, in good order, in a day, with two boys or girls to hand him the bunches. The flax should be handed with the tops to the stooker. The handfuls, as pulled, are set up, resting against each other, the root ends spread well out, and the tops joining like the letter A. The stooks are made eight to ten feet long, and a short strap keeps the ends firm. The stooks should be very narrow on the top, and thinly put up, so that they may get the full benefit of the weather. In six or eight days at most, after being pulled, the flax should be ready for tying up in sheaves of tee size of corn sheaves. It is then ricked, and allowed to stand in the field until the seed is dry enough for stacking. To build the rick, lay two poles parallel on the ground, about a foot asunder, with a strong upright pole at each end. The flax is then built the length of a sheaf in thickness or breadth. The bottom poles should be laid north and south, so that the sun shall get at both sides of the rick during the day. In building, the sheaves should be laid tops and roots alternately, built seven to eight feet high, and finished on the top by laying a single row of sheaves lengthwise, or across the others, and then another row as before, but with the tops all the same way, which gives a slope to throw off rain, and finished by putting on the top a little straw tied with a rope. In this way, if properly built, it will stand secure for months. It can be stacked at leisure, or put in a barn, the seed taken off during the winter, and the flax steeped in the following May; or it may be kept stacked, without receiving any injury, for two or three years, or even longer.

LIN RAMÉ (STICKED FLAX).

In the environs of Tournay, in Belgium, flax is grown of a most superior quality, from which Brussels lace is made. The expense of obtaining this quality of flax is nothing when compared with its great value. In favorable seasons it is sold in the green state before pulling, at from £50 to £60 stg., per acre.

E. F. Deman gives a description of the process in his treatise on flax.

The land is prepared like a garden plot, having been fertilized and enriched for several years previously. The seed used is the best Riga, five bushels of which are sown to an English acre, after which it is "Ramé" or sticked, in the following manner :—

Forked pieces of wood are driven into the ground, forming squares; upon these small poles are laid at a height of about eight inches from the ground, and on these poles, thus disposed, branches of small wood are placed. The object of this process is to keep the flax from falling upon the ground, which it would inevitably do without this precaution, in consequence of the great pliancy and delicacy of the plant, which grows to a great height.

The flax is pulled as soon as the seed begins to form, and therefore the seed is entirely sacrificed. The handfuls, when pulled, are set in circles about five feet in circumference. Poles are previously driven into the ground, forming centres, around which the handfuls are set erect; upon the top of the poles are placed caps of straw, which, spreading downwards, cover the whole of each circle from exposure to the atmosphere, and forming, as it were, a series of small huts. In five or six days it is tied in small bundles.

Although the flax has been pulled very green, it has always a little half-formed seed which must be taken off—not for its value, but because the flax must be cleansed from all its chaff, leaves and dust; and in order to remove with greater facility every particle of dust, it is exposed on fine days to the sun, and rubbed a few stalks at a time, then bleached on the grass three or four days immediately before steeping. It is steeped when the water is at least a temperature of 50°. When taken from the water it is set up in caps to dry, and when dry it is spread on the grass for three or four days, after which it is tied up in bundles and sent to be scutched and scraped.

The latter process is one of great nicety and peculiarity; it is first half scutched, and then scraped with an iron scraper, and finally brushed.

This flax is worth from £300 to £350, stg., per ton. It is estimated that when one ton of this flax is manufactured into superior Brussels lace, called "*dentelle point de Bruxelles,*" it produces £60,000.

I have often thought that some mechanical contrivance, or modification of the plan above described, as practised with such success in growing flax near Tournay, would be found suitable, on a certain scale, in the cultivation of grass and grain.

Every one has noticed the Laportea Canadensis (Canadian nettle) shooting up its lengthy stem through the brushwood pile in the corners of neglected fields, or the tiny vetch struggling by its side to gain the air and light.

Could a double net-work then, of wire or other material, be set up, at small expense, at heights of two, three and four feet, above our growing crops of grass and grain, the capillary attraction, so to speak, or the struggling of the plants to reach the unclouded light above, would be so great as to increase the yield per acre of grass and straw, and may be too, the yield of grain.

On the debit side there would be the cost of storage, of material, of laying it, and of taking it away.

The practical solution of this problem will form an interesting study in those countries where the question of food supply forces itself on intelligent minds, so that the wants of dense populations may be met.

The idea, therefore, is given to the world for what it may be worth.

HEMP AND FLAX.

HEMP.

The true hemp plant is the *Cannabis sativa* of botanists. Its fibre is so generally employed for cordage that the value of all other fibres is estimated not so much from their intrinsic properties, as from their greater or less resemblance to hemp, and especially to Russian hemp. The growth of fibre is promoted by shade and moisture, which are procured by thick sowing, but where the plant is cultivated for its resinous and intoxicating secretions, it requires exposure to light and air.

By the celebrated Jussien the hemp and the hop plants were placed in the same natural family with the nettles. In more modern works they are separated into distinct families. These two plants are closely connected in properties, as in structure.

The hop (Humulus lupulus), besides a bitter, secretes a resinous principle. Hop bines abound in fibre, and have often been proposed to be turned to useful account for cordage or paper, but as yet to little extent.

The hemp plant likewise secretes a resinous principle in its leaves, on which account these, as well as the *churrus* collected from off the young tops of the stem and flowers, is highly esteemed in all Eastern countries, on account of its exhilirating and intoxicating properties. Hence, among the Arabs the hemp has a variety of names, as "the increaser of pleasure," "the cementer of friendship," &c. By its name of *Hasheesh* it is often mentioned in the works of travellers in Egypt, Arabia, and Syria; while the name of *Bhang* is not less celebrated in the far East.

The following description of the plant is extracted from the "Manual of Materia Medica" by Dr. Royle, pp. 622–629, 2nd ed.:

"The hemp is dicecious (occasionally monœcious) annual, from 3 to 10 feet high, according to soil and climate. Root white, fusiform, furnished with fibres. The stem erect; when crowded, simple; but when growing apart, branched even from the bottom, angular, and, like the whole plant, covered with fine but rough pubes-cence. This stem is hollow within, or only filled with a soft pith. This pith is surrounded by a tender, brittle substance, consisting chiefly of cellular texture, with some woody fibres, which is called the *reed, boon,* and *shove* of the hemp. Over this we have the thin bark, composed of fibres, extending in a parallel direction all along the stalk. These fibres consist of delicate fibrils, united together by cellular tissue, and all covered by the thin membrance or cuticle.

The leaves are opposite or alternately, on long petioles, scabrous, digitate, composed of from 5 to 7 narrow, lanceolate, sharply senated leaflets, of which the lower are the smallest, all tapering at the apex into a long entire point. Stipules subulate. *Males* on a separate plant. Flowers in drooping, axillary, or racemose panicles, with subulate bracts. Perianth 5—parted, segments not quite equal, downy. Stamens 5; filaments short; anthers bare, pendulous, 2 celled; cells united by their backs, opening by a

longitudinal slit. *Females* in a crowded spike-like raceme, with leafy bracts. The perianth consists of a single small spathe-like sepal, which is persistent, acuminate, ventricose at the base, embraces the ovary, and is covered with short, brownish glands. Ovary subglobular, 1-celled, with one pendulous ovule. Style short, Stigmas 2, elongated, glandular. Nut ovate, greyish colored, smooth, covered by the calycine sepal, bivalved but not dehiscing, and inclosing a single oily seed. Seed pendulous. Testa thin, membranous, marked at the apex with colored hilum. Embryo without albumen, doubled upon itself, Radicle elongated, turned towards the hilum, and the apex of the nut separated from the incumbent plano-convex cotyledons by a small quantity of albumen."

Some very valuable information on the production of the hemp plant in India will be found in a Report on the subject by Dr. Royle, in the year 1839, which was published in the Trans. of the Agri. Hortic. Soc., Vol. viii. p. 15.

"Hemp is cultivated in almost every part of Europe for home consumption, but only in large quantities for export in Russia and Poland, though the finest quality of hemp comes from Italy. In America large quantities are produced in Kentucky, and Missouri.

The soil must not be over rich nor too sterile, of moderate depth and friable. In Russia the time of sowing varies from the middle of May to the end of June. The season of reaping is from the end of August to the end of September, and it is therefore between three and four months in a state of vegetation; the male plants being pulled some weeks before the female. The Russian summer, though short, is regular while it lasts, and the temperature sufficiently high to bring it to perfection.

Large quantities are grown in the Southern climate of Italy, both in Bologna and Romagna, and along the banks of the Po, as in the neighbourhood of Naples. The Italians have a saying, that 'hemp may be grown everywhere, but it cannot be produced fit for use either in heaven or earth without manure.' The climate of Italy, it is well known, is remarkable for its clearness, regularity, dryness, and warmth. The Italian hemp is fine, soft, light-colored, and strong, as well as long in the staple; and it sells for 50*s.* per cwt. in the English market, when the best Russian sells at 47*s.* for the same quantity."

Hemp being one of the few cultivated plants which has the male and female flowers in different plants, affords some anomalies in its culture, especially that of having two harvests in the same crop.

Soil.—The soil in which hemp thrives, is a deep, rich, moist soil, five or six inches deep; besides the alluvial, where sand and clay are intimately mixed, and having the above characteristics; also the friable loams, which contain much vegetable matter. All should contain a fair portion of sand, as this keeps the soil open and light for the roots to spread in. Stiff, cold clays are unsuitable; for even if the plant should grow well, it is not easy to pull it; for when strong clay becomes saturated with rain, the soil runs together, and on drying sets as hard as a pavement. If the soil be over-rich, the plant grows too luxuriantly, and produces a coarse but strong fibre. But hemp is sometimes sown in such soils to meliorate them for the cereals, which would otherwise run too much to straw. But as many soils are too poor, they require to be raised to a suitable state by the addition of manure; and with this, it is said that hemp may be grown in the same soil for many years. When a fine quality of fibre is required, of course, only the most suitable soil should be selected, or that in which the growth of the plant is neither excessive nor stunted. In Italy, hemp is sown in their best lands, which are rich and strong loams, and made fine and friable.

Culture and Manure.—At Soonamooky, hemp grows luxuriantly in sand, manured with stable dung. But the richness of the soil, and the quantity of manure required, must vary, not only according to the nature of the soil and its requirements, but also to the warmth of the soil, and the nature of the

climate. Warm, moist ones require less than cold, whether dry or moist climates. In England, Mr. Rowlandson says, the generality of soil will require a dressing of ten tons of well rotted farm-yard dung per acre, ploughed and harrowed in early in April. The land should, of course, be in the first instance well ploughed and properly drained; also well harrowed and rolled, to get the top-soil into good tilth; and weeds, as horse-mint, or twitch, destroyed. The manure must be carefully and evenly spread, and the plough follow close to the spreader.

Seed.—Of seed, that from Holland is the most esteemed, ripens soon, yields abundant crops, and of a fine quality; but well-grown English seed is also of good quality. Indian seed, from external appearance, appears fine, but may not be so well suited in the first crop for fibre; but the Himalayan seed, both from its appearance and the nature of its produce, is probably inferior to none, and perhaps only requires interchanging. The seed should be of a bright grey color, and plump; and must not have undergone heating in any way, and therefore the taste, when bitten, should be sweet, and not bitter or acrid.

The quantity of seed may vary from two to two and a half, others say to three bushels an acre; the last if a fine fibre is required, for weaving into cloth. But the larger quantity cannot be sown on very rich soils. The thicker it is on suitable land, the finer it will grow. The fresh-ploughed land should be sown very evenly, care being taken to scare away birds. The best time for sowing, in England, is from the first to the 15th May, as frosts are apt to injure the young plants; but late-sown plants are apt to grow thin and weak.

After-culture.—Hemp seed is sown both broadcast and in drills. When grown on account chiefly of the seed, it is sown thin. Sinclair says, by sowing hemp in drills, a coarser and stronger bark or fibre, fit for cordage, will be produced, and a less quantity of seed is required than by sowing it broadcast. This latter mode is to be preferred, when hemp is wanted for textile purposes. The stems rise slender and fine, according to their proximity; but they require to be weeded. In general the hemp will itself smother all weeds, except in the spaces between drills. During its season of rapid growth, the plant necessarily requires moisture, and therefore, in some countries, irrigation is practised.

Pulling.—As already observed, hemp has usually two harvests; but when grown on account of the fibre only, it may be pulled when in flower, and no distinction made between the male and female plants. But as it is usually desirable to get both the seed and the fibre of both plants, the male plants, or white hemp, are pulled as soon as they have shed their pollen, usually about thirteen weeks after they have been sown. They may then be easily recognized by their leaves becoming yellow, and the stem of a whitish color, and the flowers faded. Each plant is pulled up singly by the root, care being taken not to break or cramp the stem in the hand. The ripeness of the female plant is known not only by many of the same signs as those of the male, but also by the seeds beginning to turn of a grey color, being firm inside, and some of the capsules to open. When the seed has become perfectly ripe, the bark is apt to become woody and coarse, and to separate with difficulty. But the seed which is required for sowing ought to be taken from plants allowed enough of room to spread, and then to fully ripen their seed.

Drying.—When the plants are pulled, it is recommended to hold the root-end uppermost, and with a wooden sword dress off the flowers and leaves, as

they assist in manuring the land. They are then bound in small bundles with bands at each end, of such a size that you can grasp with both hands, or sometimes into bundles of twelve handfuls each, and arranged along the borders of the field. If not done before, knock and shake off the soil from the roots, and scrape off the undergrowth of leaves. It is then set up like wheat in shocks, for a week or so. The stalks which form each handful should be as nearly as possible of an equal length, and the roots in particular should be placed as even as possible. If the crop is kept till spring, it is tied in larger bundles and stacked and thatched.

Gathering Seed.—When the female hemp is gathered, it is allowed to stand eight or ten days in the air, to allow the seed to dry and ripen, the tops being covered with undergrowth, to keep off the birds, after which, cut off the heads, or gently beat out or thresh them to get out the seed, on a cloth. The seed which remains after this operation is got out by combing the heads on the teeth of a ripple; but the seed is inferior to that which first falls out, and is unfit for sowing. The female plant is generally stacked during the winter, and not steeped till the spring.

Drying.—When the hemp has been pulled, it ought, according to some authorities, to be dried in the sun for one or two days, but Du Hamel observes that it is a matter of doubt whether the plant should be dried before it is steeped; so Mills, in his 'Husbandry,' like the natives of India with their Sunn, thinks that this drying appears needless trouble. So Marcandier directs, that when the hemp is perfectly ripe it must be put into the water as soon as it is pulled out of the ground; and Sinclair says, that hemp should be watered as soon as possible. In this state it is said to require only four days, but, when it has been dried, eight days of steeping. The time must, moreover, depend a good deal on the temperature of the water.

Steeping.—The steeping of hemp, called *water-retting*, is a very important part of its preparation, and is to be distinguished from another method which is called *dew-retting*. The steeping places are often only ditches, three or four feet deep, varying in breadth and length, dug for the purpose on the margins of rivers. The bundles of hemp are laid at the bottom of the water, and covered with straw, and sometimes with sods, and loaded with pieces of wood and stones to keep them down. The object, as in the case of flax, is by a slight degree of fermentation to enable the epidermis, or outer skin, to separate readily from the bark, and this from the boon or reed. This is readily ascertained by taking out one of the steeped stems, and holding it by the root end, and drawing the thumb-nail up the stem to the top. If the fibre slip up the stem. it is a proof that it has been sufficiently retted.

Du Hamel, having steeped hemp in different sorts of water, observes that the fibres steeped in putrid standing water were softer than those which had been steeped in running water. But in water which does not run, the fibres contract a disagreeable color; they are, however, notwithstanding this, easily bleached; it is desirable, however, to make a small stream of water pass through the steeping place.

Du Hamel, referring to the common opinion, that hemp intended for fine cloths should be retted more than that for coarse cloths, and that for making of ropes should be steeped least of all, observes, that though there may be some truth in this, it is in vain to hope greatly to improve, by this process, fibres which are naturally coarse. A fine fibre cannot be obtained

without the concurrence of soil, of seasons, and of climate, the mode of sowing and of culture, and the degree of ripeness.

Drying after Watering.—When the hemp is sufficiently retted, it is taken carefully out of the water, and then carried to a field of aftermath or any other grass (hence called "grassing") that is clean and free from cattle. here it is spread out very evenly, and will probably require to lie there for three weeks or more, in order to bleach, and the fibre to become free; during which time it must be carefully turned over with light long poles every three or four days. Mr. Rowlandson says it is sufficiently bleached when pink spots appear on the stem. It is sometimes dried along a wall, or on rocky ground. When dry, the hemp is tied up in bundles again, and carried to the barn or rick.

Peeling and Breaking.—When the hemp is sufficiently dried, the next process is either to *peel* it, by taking one stalk after the other, breaking the reed and slipping off the bark. The process is simple but tedious, and will give occupation to those who are without any. But it comes off in ribbons which do not heckle so well as hemp that has been broken, and they are apt to retain some of the thick parts next the root, hence the saying that this mode is better for the seller than the buyer.

The term of breaking or braking hemp, applies rather to the boon or reed than to the fibre, for this only bends under the hand of the dresser, and does not break. The operation is performed either by beating the hemp, which is a laborious and tedious work, or by the break, which may be moved either by hand or by a spring or treddle attached to the upper jaw of the break, or by fluted rollers, worked by horse, wind or water, and now sometimes by steam power. When hemp has undergone the process of breaking, it is ready like flax, for the process of scutching, in which scutching mills are now used, as in the case of flax. By rubbing, beetling, and striking the hemp with reiterated blows, the longitudinal fibres are separated from one another, and in proportion to the greater or less degree of that separation, the hemp becomes more or less fine, elastic, and soft to the touch.

Dew-retting—Mr. Rowlandson says (1 c., p. 180)—will produce the most valuable white hemp. The stems, after being pulled, are allowed to stand in the stooks for two or three days; they are then spread out on land where the grass is plentiful, and may require to be there for six weeks, and to be frequently turned. The process will be completed when the pink spots appear, as before noticed, which must be carefully looked for, when it will be ready to gather and tie up in bundles, to form stooks, in order to dry; the fibre will not sustain any damage before the pink spots appear. *Snow-retting* is practised in Russia and Sweden. After the first fall, they spread the hemp (which has been dried in the sun or otherwise) on the snow, and leave it there to be covered with other falls of snow, until Spring, when it is usually found to be sufficiently retted (Wisset, p. 194). In Livonia they steep their hemp in a manner which is a medium between still and running water, in a series of basins, one above the other.

In addition to the ordinary methods of preparation of hemp there are others which may be briefly noticed.

The Abbé Brulles recommended the use of soap in the proportion of one part to forty-eight of water, at a temperature of about 200° F., and the water to be about forty times the weight of the hemp. Du Hamel tried boiling the

hemp stems in water, but he did not find that the peeling was facilitated. Marcandier recommended a second watering, and also the use of a warm alkaline ley, (1 c., pp. 243 and 245).

We have seen the use of hot water successfully applied to flax in recent times, and soap has been used in several processes, and in a very ingenious manner in one in which a little acid is afterwards added, so that decomposition takes place, in consequence of the acid uniting with the alkaline base, when the oil which is set free assists in softening the fibre.

There is a peculiar method of drying, to which the Livonians are said to ascribe the good or bad quality of their hemp. The stems are first set up to drain, and then spread out for a day to dry; after which they are made up in heaps, and covered over with straw, or other similar material of any kind, to make them *sweat*. When they have sweated *enough*, they are laid again in small heaps, so that the air may dry them in the shade by blowing through them; after which they are effectually dried by fire, kiln, or oven, and immediately put under the breakers whilst yet hot. Dr. Royle observes, it is probable that this method, when skilfully practised, must produce some of the same effects in hemp as in some other vegetable substances. Mr. Frushard remarks, with regard to the natives of India; "The reason why their tobacco falls so much to dust, is owing to its not being *sweated* enough. When properly *sweated*, as they manage it in America, it becomes tough like a bladder; and toughness and suppleness are the qualities wanted in hemp." (Wisset, p. 223).

Besides these, there is also the dry method of separating hemp in some places, as related by Mr. Durno, who was the British Consul at Memel, and who states that in the Southern parts of Poland, steeping is not practised at all, on the supposition that the harle is thereby weakened, and the color darkened. Instead of steeping, they there dry the stalks in the sun. But the dressing is more laborious, and consequently more expensive. Mr. Dickson (of England) has succeeded admirably in separating hemp fibre by passing dried stems from Italy under the rollers of his machine.

Crop and Profit.—Mr. Rowlandson says the best land for obtaining fibre of the strongest description is a fat loam, not too heavy with clay, and a portion of sand intermixed. On such land, succeeding a crop of beans, hemp will grow six or seven feet high, and bean stalks in such make good manure for hemp. He adds: "I have known 9 quarters of beans per acre after hemp, weighing 21 stone per sack. Hemp after beans will produce 30 stone more per acre, of the strongest and heaviest fibre, than by any other mode of culture; the weight of fibre in ordinary culture and circumstances will produce 60 to 70 stone per acre." A good crop of hemp after beans will produce 28 to 30 bushels of seed per acre; in the ordinary way, 20 to 22 bushels per acre.

The co-operation of purely manufacturing establishments will facilitate and give advantages to the production of hemp, as to that of flax.

The following table shows the imports of hemp from Russia and the British territories in India, from 1847 to 1851. In the year 1831, 506,803 cwt. were imported from Russia, and only 9,472 cwt. from the East Indies.

Quantities of Hemp imported into the United Kingdom from

	1847.	1848.	1849.	1850.	1851.
Russia	544,844	540,207	641,548	614,535	672,342
Brit. Territories in E. Indies.	185,788	258,239	360,362	399,345	590,923

Hemp at Petersburgh is assorted into clean hemp, or firsts; outshot hemp, or seconds; half-cleaned hemp, or thirds; and hemp codilla. Riga hemp is distinguished as rein (or clean), outshot, and pass hemp.

Particular care is taken to ship hemp or flax in fine, dry weather. If either get wet, they are apt to heat, and to be totally spoiled. For this reason every vessel taking in hemp or flax is furnished with mats to prevent their getting damp.

A bundle of clean hemp weighs from 55 to 65 poods; ditto outshot, 48 to 55 ditto; ditto half-clean, 40 to 45 ditto (1 pood = 30 lbs. avoirdupois).

To every bundle of assorted hemp is attached a ticket, with the names of the selector, binder and owner, and the date and year. Every bundle has also affixed to it a piece of lead, stamped on one side with the name of the selector, and on the other with the sort of hemp and the time when it was selected. The external marks of good hemp are, its being of an equal green color, and free from spills; but its good quality is proved by the strength of the fibre, which should be fine, thin and long. The first sort should be quite clean and free from spills; the *outshot* is less so; and the *half-clean* contains a still greater portion of spills, and is moreover of mixed qualities and colors.

As a perfect knowledge of the qualities of hemp and flax can only be acquired by experience and attention, agents usually employ men constantly occupied in this business; by which means they are sure of getting goods of the best quality, and have the best chance of giving satisfaction to their principals.

The part separated or picked out in cleaning hemp, is called *hemp codilla.* —(*Borrisow on the Commerce of Petersburgh.*)

With regard to prices, those of hemp will of course vary at different times, like those of all other products. It is usually highest in the summer months, and lowest in September.

In December, 1833, Petersburgh clean hemp was 25*s.* to 26*s*; Riga rein at 29*s.* per cwt.

In the year 1840, Italian hemp was at 50*s.* the cwt.; Polish rein, 48*s.*; Petersburgh clean, 47*s*; Petersburgh half-clean, 42*s.*

At the end of 1854, Petersburgh clean, £60 10*s.* to £63; outshot, £59 to £61; half-clean, £57 10*s.*; Riga rein, £61 to £64.

PART II.

FURTHER OBSERVATIONS ON THE CULTURE AND MANIPULATION OF HEMP IN DIFFERENT COUNTRIES.

"The soil for hemp," says Olivier de Serres, should be fat, fertile, easy to work, and in a temperate climate." It is found that it will do very well after turnips on friable loams and good sands, provided they be well manured Spalding Moor, in Lincolnshire, is a barren sand, and yet, with proper care and culture, it has produced as fine hemp as any in England. In the Isle of Axholme, in the same county, the culture and management of it has been the principal employment of the inhabitants; and according to Leland it was so in the time of Henry VIII. On sandy loams the quantity is not so great as in a black rich mould, but the quality is much finer, and therefore better adapted to the fabric of hempen cloth. Hemp, in short, delights in valleys and the banks of rivers. Fresh broken lands in the midst of woods and forests are favorable to its growth; so also are gardens and other spots that have long been cultivated by the spade. The same is the case on a crop of broken up lucerne, on land in good heart, after a crop of oats has been taken; on broken up pasture land, and fresh drained marshes, and newly emptied pools. Count Gallesio regards as the best composition of hemp land that which is composed of one-third of silex, one-third of lime and magnesia, and another third of clay. "This mixture," he says, "forms a light soil, which does not harden and form a crust. The seed, sown thickly on such land as this, rises perfectly; the plants, finding themselves crowded, are unable to increase in bulk and breadth, and therefore shoot up lank and slender. Well rotted manure, acting immediately, favors and accelerates the development of the plant in an upward direction."

Hemp is esteemed a clearing crop, for it destroys all weeds that spring beneath it by overshadowing them and depriving them of their nourishment. As a general rule, it should not be too often repeated on the same ground. It may, however, be grown with success on the same land many years, by manuring annually; it is said it has been sown on the same for seventy years together. There is no doubt that by the unsparing use of fertilizers, almost any result can be obtained in gardening and agriculture. Hemp, if it stands for seed, is on all hands acknowledged to be an exhausting crop; but if it be cut or pulled without the seed, it is supposed by many to improve the land, and to be an excellent preparation for wheat.

"British Husbandry" testifies to the same effect. "Opinions differ in regard to its effects upon the soil, some considering it as a great exhauster, and others only in case of its being allowed to stand for seed, but all agree in admitting it to be an effectual cleanser of the land, for it grows with such

promptitude and strength that it destroys all the weeds which spring up under it. It therefore can never be sown along with grass-seeds; but, for the same reason, it is found to be an admirable preparation for a crop of wheat, as the land must be previously brought into a state of garden culture, and, if heavily dunged, when treated in this manner, alternate crops of wheat and hemp have been successfully grown upon the same ground during a series of years."

THE PLACE OF HEMP IN THE ROTATION OF CROPS.

The Baron de Morogues, in his essay on the means of improving agriculture in France, observes that as hemp is sown late in spring, the land may be made to bear two crops in the year, by causing the hemp to be preceded by green food of some kind or other. Thus, in the Department of Maine-et-Loire, hemp is sown in May, immediately after a crop of *raves*, or large, yellow field radishes, which answer many of the purposes of turnips; and in the Department of the Pas-de-Calais, it is made to follow a crop of *escourgeon*, or four-rowed winter barley, mowed green.

Combining hemp and flax with the Norfolk four-course system, on rich and deep soils, a convenient rotation would run as follows:—1st. Turnips, fed off on the land by sheep; 2nd. Barley, sown with grass or clover seeds; 3rd. Hay or pasture, for two years; 4th. Flax, which never does better than on the upturned sod; 5th. Turnips again, or beetroot, heavily manured, resting the land, and helping to make manure in turn; 6th. Hemp; 7th. Wheat. Between the flax and the root crop which follows it, it would be easy to steal a crop of green food (vetches and rye) to be cut or eaten on the land in early spring.

TIME OF SOWING AND CHOICE OF SEED.

The time of sowing hemp varies greatly according to the climate, and in the same climate according to the locality. It extends as widely as from the month of March to the month of June. The grand rule is to avoid all danger of severe spring frosts, as the plant is liable to be affected by them. Still early sown hemp is always the best. Great care must be taken to sow none but last year's seed; old seed will not come up at all, or at best very uncertainly. With hemp, as with flax, the question of thin or thick sowing must depend upon the object of the grower and the quality of the land. In fact, on middling land, hemp should be sown thinner than on heavy land. When it is wanted to procure a very long and fine sample of fibre, thick sowing is necessary; because the stems then draw each other up, and even blanch each other to a certain degree, thereby causing the bark to be more delicate. Hemp which grows so wide apart as to throw out side branches, produces a large quantity of seed, and a very strong fibre, but which is only fit for ropes or the coarsest cloth. It has been found by experiments in England and America, that salt sown at the same time with the hemp-seed, acted as a beneficial stimulant. In the neighborhood of Bologna and Ferrara, in Italy, where the culture of hemp is probably carried to greater perfection than anywhere else, where it is not uncommon to see hemp stalks rising from twelve to sixteen feet above the surface of the ground, it is usual to spread at the same time with the seed fecal matters, the dung of fowls, powdered oil-cake, and chips of horn and bone.

In the Department of the Pas-de-Calais, which approaches very nearly to the climate of England, the rule is to sow hemp from the 10th to the 20th of

May, at the same rate as is usual there for wheat and flax, namely, a *hectolitre* to a *mesure* of forty-two *ares* twenty *centaires*, more rather than less, in case any portion of the seed should fail to vegetate. This answers as near as may be to the proportion of two bushels to the acre.

It is a well-known fact that the most substantial manures, if they are not well rotted, produce a less active effect on the growth of hemp than the simplest fertilizers, which have been reduced to a state of extreme division. Hemp has short and slender roots; it springs up, grows, and comes to maturity within a very brief space of time; it therefore requires to find its nourishment readily prepared and easily absorbed. On this account all sorts of vegetable manures are found to answer so well. The Italian hemp-growers are fond of ploughing in green crops, such as field radishes, and lupines, as manure for their hemp, and thereby obtain both quantity and quality in their sample.

As all sorts of graniverous birds are passionately fond of hemp seed, it is indispensable to protect the new-sown fields, or to have them watched by children.

M. Bose relates a curious fact, which some would pronounce incredible. A Piedmontese farmer, M. Barberis, having a hemp-field seriously injured by hail, cut half of it to the level of the ground, and left the other half standing for the sake of comparison. The portion cut yielded a crop, not only more abundant than the other, but more than the same extent of ground would yield in seasons when no hail had fallen.

The hemp crop is not all gathered at once, the male plants being generally pulled a few weeks before the female or seed bearers. This usually occurs towards the middle of August. Their ripeness is known by their turning yellow at the top and white at the root, and by the general tendency of the whole plant to wither. Those who are over anxious about the quality of their fibre are apt to pull the male plants too green. In this state they produce a sample which is excellent for the manufacture of cloth; but if the hemp is to stand for seed, it is better to let the male plants remain till they have shed their dust, without the influence of which the seed will prove abortive, and be worthless both for the oil mill, and for birds' food. An acre of hemp on rich soil will produce something like three quarters of seed, a matter of some importance. If the crop be destined for spinning only, without any regard to the seed, the male and female plants are pulled together as "Maiden hemp," about thirteen or fourteen weeks after seed time; the plan has this advantage, that the crop comes off the ground sufficiently early in some climates for turnips to follow it, or better, that the farmer is allowed full leisure to make due preparation for a crop of wheat. The separation, however, of the male and female plants is not universally, though it is generally observed. It is sometimes neglected partly from the fear of the injury which the pullers would do to the remaining plants by crushing and breaking them when they stand thick, and also because the work has to be done at a busy time of year when there are plenty of other things to think of. When the hemp is pulled, it is bound in small bundles of such a size as may be grasped in both hands, and tied together with bands, at each end; they are then set leaning head to head against each other in the field to dry. In the Pas-de-Calais, the female or seed bearing plants when gathered after the males are disposed of, have their heads knotted into wisps to keep the seed from falling off (which it is

very apt to do), and also to make it heat slightly; for which purpose it is sometimes even wetted a little, after thrashing, and subjected to the same granary treatment as is practised on rape and colza seeds, to cause them to mature their oil. There are many ways of thrashing the seed, or rather of removing it from off the stalk. In some places, large cloths are spread in the field, and the heads are laid on a bench standing on the cloth, and are beaten with sticks; in others, the heads are beaten over a tub with its head staved in. Nowhere is the flail employed, least it should crush the seed.

Hemp seed is winnowed like wheat, and put in the granary in small heaps, which should be shifted occasionaly to dry it thoroughly.

In large towns, the consumption of hemp seed for cage birds is very considerable. Hemp seed oil is excellent for burning in lamps; it is used in painting and the manufacture of soft soap. The oil cake left after the crushing process is eaten with avidity by many domestic animals, and is often employed as manure.

The thrashing over, the hemp is ready to undergo the important operation of steeping. When hemp is of the tallest kind, the plan of pulling it ought to be rejected, and it should be cut by a scythe, or reaping machine.

HEMP STEEPING, &c.

The importance which the culture of hemp has attained in the north of Italy is well known; and a detailed account of the mode of steeping which the hand-working peasants make use of there, will be interesting to lay before the reader. The translation is from the French of M. de Crud, who has described them in his "Economie de l'Agriculture."

"Hemp ponds, or *routoirs*, are usually dug in the earth, sufficiently deep beneath the surface of the soil to keep them always full of water. These ponds are provided, over their whole extent, with stakes driven into the earth to the depth of seven or eight feet, to prevent their being pulled up by the effort which the hemp makes to rise to the surface of the water. They are also fixed in regular rows, about six feet apart; and as they support, not far from their top, wooden cross-bars, about six inches broad, and an inch and a half thick, which stretch from one to the other in the same direction, they form a sort of alleys in the water. These stakes ought not to rise higher than just a trifle below the usual level of the water, to prevent them decaying from the alternate action of dryness and moisture. The pond is ordinarily about five feet deep, except near the edge, where there is made a sort of bank of planks. On this bank the workmen walk, up to their waste in water, for the purpose of washing the hemp before taking it out of the *routoir*.

"To steep the hemp, they place in these alleys the bundles, as carefully sorted as possible. The bundles are laid *lengthwise* in the alleys, and as many are brought in as will fill the whole breadth of the alley a couple of bundles deep. They then take pieces of wood, of the same dimensions as the cross bars, and about a foot longer than the breadth of the alleys. One of the ends of the piece of wood is introduced beneath one of the ends of the cross-bars which enclose the alley, passing over the bundles of hemp; then, by pressing the other end down, they force the hemp to sink in the water, till the other end can be slipped under the cross-bar which is nearest to it. It is evident that the cross-bar obliges the hemp, in spite of its buoyancy, to sink in the water and to remain submerged. Each end of the bundles of hemp must be held down by one of these pieces of wood. Up to this point, all the operations connected with the steeping are performed by men, who walk upon the tops of the stakes, on the cross-bars, and on the hemp itself, without going into the water. These men make use of poles, furnished with iron hooks at their end, to lay hold of the bundles and arrange them in the water according to their convenience.

"There are a few ponds on a different plan: instead of driving in stakes, and making wooden benches, no more is done than to pave the bottom, or to line it with bricks and

masonry. All round it the sides are kept up by walls, also of masonry, and the hemp is sunk in the water by means of great stones laid on the top of it. This is the plan adopted in Spain.

"When the hemp-grower has no pond, of either one sort or the other, he steeps his crop in runs of water, and in the bed of rivers, fastening it with ropes, for fear any sudden flood should carry his property away with it; or sometimes in ponds that have been dug for the purpose, in which the bundles of hemp are made to sink by loading them with earth, which has been taken from the bottom of the pond itself. Hemp which has been steeped in this last mentioned way is always much more dark-colored, and its fibre is often sold for one-sixth less than the other sort. In those ponds which are not fitted up with stakes, the workmen who set the hemp to steep are obliged to work in the water.

"Four days after steeping has commenced, it is necessary to inspect the hemp, and to try if the fibre comes away easily from the woody part. It is very essential to seize the moment when that change takes place; for twelve hours passed in the *rouissoir* beyond the necessary time, would considerably injure the quality and the strength of the fibre. About the sixth day the steeping is generally complete; but that depends greatly upon the weather and the temperature. If a very strong fibre is required, in preference to a very sightly sample, the hemp ought to be taken out of the water as soon as the fibre begins to detach itself, when the hemp-stalk is broken. If, on the contrary, good-looking rather than strong hemp is required, it is left in the pond for twelve or eighteen hours longer.

"The next step to be taken is the washing. A party of women, dressed in wretched rags, step into the pond, and stand upon the bank which has been purposely built: there they are up to the middle in water. Men (if the pond is staked, but if not, the women themselves) then unfasten the bundles of hemp by breaking the bands with which they are tied, in order to separate the bunches from each other. The women then, seizing these smaller bunches with their two hands, and raising them several times as high as their arms can conveniently reach, dash them horizontally with their whole strength upon the water, turning them round a little each time, in order that every part of the bunch may feel the effects of the blow. This operation detaches almost the whole of the fibre from the woody part of the hemp, and at the same time cleanses it from the mould and filth which hang to it. After having repeated these knockings of the hemp on the water for three or four times, the workwoman seizes the bunch by the little end, and driving it through the water in the opposite direction, thereby causes the fibre to be detached from the lower extremity of the stem; then, rolling the bunch in the water, she causes the separated fibre to twist itself round the bunch, with the object that when the hemp is set out to drain and dry, the fibre may not come in contact with the soil. All the steeping ponds are surrounded by pasture land, to serve at the proper season as drying grounds for the hemp. After having washed each bunch in the way we have just described, the workwoman throws it on the green turf; a workman seizes it and sets it on its big end. It supports itself by leaning against the other bundles. In that position the hemp drains. About one o'clock in the afternoon the women come out of the *rouissoir*, dress themselves in dry clothes, eat their dinner, and then proceed to drying the hemp.

"The women now, if they have not done so before, push to the upper end of each bunch the band with which it was tied round the middle; and opening every bunch at the bottom, they spread the stalks that are standing on the grass with their heads aloft and leaning together, almost in the same way as a pile of muskets. The hemp is thus perfectly exposed to the sun and air; nevertheless, even when no rain happens to fall—a circumstance greatly to be desired, especially to preserve the beauty of the fibre—it takes two days at the very least to dry it completely. If high wind comes on, the bunches out drying are often blown down, and must be set up again as quickly as possible. Towards evening, the hemp which has attained the necessary degree of dryness is loaded on carts, and carried to the hemp barn.

"It will be remembered that the hemp is often four yards long, and more, even after the top is cut off, because the fibre which that part would give is nearly worthless. This great length is necessarily accompanied by a certain degree of thickness, which makes it impossible to clean the stems by means of ordinary scutches, like those used for flax, unless they were made of such a size and weight as would render their use impracticable in any other hands than those of a giant. Recourse is therefore had to the following method:—An upright wooden block is fixed in the earth, about a foot broad,

and three feet long at its upper surface, which is cut out in such a way as to leave it of the form of a hollow crescent. Moreover, the edges of this rude crescent are smoothed and rounded so as to present to the fibre a completely even and regular surface. A workman then takes the bunches one after the other, and, beginning by presenting them by the thicker end, he lays them on the block and pushes them forward, so as always to have six or seven inches of unbroken stalk beyond the block. Meanwhile, a couple of women, armed with hard, thick sticks, especially clumsy towards the end, something in the style of clubs, beat the end of the bunch as the workman pushes it forward. A single blow is sufficient to crush it, so that if the bunch is twelve feet long, it requires about ten blows from each woman to crush it, the upper extremity which the workman holds in his hand not being subjected to the operation. If the people are expert in this work, a minute will be more than time enough to crush three such bunches. As soon as the man who holds the bunch has advanced it nearly to the end, he leaves hold of it with one hand to seize another, in order to substitute it for the former one the moment he has finished it, and to continue the operation without interruption. That the workman who lays the bunches on the block may continue that task, the woman who brings him the bundles of hemp takes care to place them ready to his hand. The fibre often comes out of this operation completely divested of the woody stem throughout the whole of its length, except at the extremity which the workman held in his hand. Two other scutchings or beatings take place with smaller tools. At the last one, the workman is not content with beating the fibre; he pulls it while it is pressed with his tools, to soften it and clear it from any knots and bits of chaff that may still remain adhering to it. The fibre is then folded in two, and packed in bales to be delivered to the merchant."

The following judicious observations are from the Abbe Rozier, relative to the sanitory precautions desirable to be observed with steeping ponds:

"Whether the water is stagnant or running, and in whatever spot the *routoir* may be situated, it is essential to plant rows of trees around it. Poplars are preferable to any others. One of the grand agents which nature employs for the purification of the atmosphere, is the vegetation of plants and trees. They feed upon the impure air given out by steeping ponds, appropriate it, and in return give back pure air to the atmosphere. But even with this resource at hand, it will be seen that the establishment of *routoirs* in the vicinity of dwelling houses is an extremely unhealthy and imprudent practice, since the trees cannot entirely absorb the enormous mass of mephitic air which escapes from hemp in a state of putrid fermentation. Spots ought to be elected which are exposed to the wind and open to violent currents of air.

"It is useless to make steeping ponds too broad, at least they are very inconvenient. I should prefer extending them in length, whenever required, particularly if they are to serve for a community of hemp-growers. In that case, every individual finds his own place, without disturbing that of his neighbour, and a smaller quantity of water is required. The bottom ought to be paved, with a slope towards the place where the water is let out. There ought, indeed, to be a double outlet, one at the surface and one at the bottom, either to be used as occasion may render convenient. The sides should slope with so steep an inclination as to allow the workpeople to approach with ease, and not be obliged to enter the water in order to arrange or alter anything in the hemp heap, as will be necessarily wanted from time to time. The sides, if not built of stone or brickwork, should be covered with cement of sufficient thickness. The mud taken every year out of the bottom of the steeping place, makes excellent manure."

Mechanical processes have been proposed as a substitute for the water-retting of hemp. But the reason why these machines must ever be incompetent to perform the office required of them, is clearly explained by the Count Gallesi, the author of an excellent Italian memoir on the culture and manipulation of hemp and flax:

"Maceration," he says, "is an operation indispensable to obtain from the hemp plant a tissue suitable for making cloth. It may be said that it can be dispensed with in the case of hemp for rope-making. I do not admit the supposition; but even granting it, the same thing cannot be admitted with regard to hemp destined for cloth. The bark of the hemp is the portion which furnishes the tissue; it is composed of an infinity of longtitudinal fibres, lying one over the other, and joined together not only by the force of adhesion proper to vegetable tissue, but still more strongly by a sort of gummy

substance, which unites it to the woody part. No mechanism whatever can clear the rind from this substance, and still less the woody stem, which also contains it."

In the Pas de Calais, where hemp grows only to the same moderate height which it attains in Great Britain, the stems are not scutched or beaten, like flax, to obtain the fibre, but it is peeled off by hand. This work is performed during their evenings, by work people, together with their whole families, who employ themselves in hemp-peeling when their day's work is done. A child of four or five years old is capable of executing the task. The head of the hemp stalk is simply broken with the fingers, and the whole of the fibre comes away with it at once. The string of fibre is thrown on one side, and the denuded hemp stalk is cast on the other to make sulphur matches with, for which purpose it is in great demand, the consumption for pipe-lighting being enormous in France. The match makers buy their bundles of naked stalks in pairs, one bunch of male, and one of female stems, that is, of shorts and longs. Each individual can earn two *sous*, or a penny, per evening by hemp peeling. The people are satisfied if it pays them for their candle and their tobacco.

PART III.

ROPE-MAKING.

It has been long discovered that we may obtain length by twisting fibres together, when they press upon each other, so that any single fibre is unable to overcome the resistance caused by the friction upon it of surrounding fibres. It will then break more readily than slip out from the mass. By this means a certain degree of compactness is also obtained, so that the infiltration of water is prevented, and the rope preserved from decomposition. Though a certain degree of twist is essential, any excess is injurious; for a rope may be so twisted as to break in the operation, and therefore a rope, brought up to this point without breaking, would be unable to bear any further strain, or to support any weight at all, and consequently be useless. Great precautions are therefore necessary in twisting the fibres, so that they shall retain as much as possible of their original strength, and be preserved from sustaining any further injury.

In making a rope, the first operation is to twist a certain portion of the fibres into a thick thread, which is called a *yarn*. These yarns vary in size, from one twelfth to a little above one-ninth of an inch in diameter. They are then *warped*, or stretched so that they may bear any strain equally. The next process is to twist a number of yarns, say from fifteen to twenty-five, into a *strand*. The twist of the strand is in an opposite direction to that of the yarn of which it is composed, in order that any tendency in the yarns to untwist may be counteracted by an opposite tendency in the strand. Three of these strands are formed into a *rope*, and three ropes into a *cable*. The term rope is generally confined to those which are above an inch in circumference; those which are less being called *twine*, *line*, and *cord;* though some of the latter terms are used with less strictness, as *fishing lines* and *clothes*

lines are of very different diameters. Other kinds are distinguished by the name of ratline or of lashing; sometimes they are distinguished by the weight of a certain quantity—thus, pound line signifies a line weighing 60 yards to the pound; 160 fathoms of white or untarred yarn weigh from two and a half to four pounds.

In a popular work by Mr. Tomlinson, the different operations of rope-making are described as follow:—1. *Heckling*, or hackling, of which the object is to separate the short fibres or tow, and to straighten the long ones, in order to enable them to run freely in spinning. 2. *Spinning*, or twisting the fibres into threads or yarns. 3. Tawing the yarns. 4. *Twisting* the yarns into strands. 5. Laying, or twisting three strands together, so as to form what is called a *hawser-laid* rope. In this process, which is called the *first lay*, each strand consists of as many yarns as are found requisite to give the required thickness to the rope. 6. *Second lay*, or *shroud hawser-laid rope*. This consists of four strands laid in the same way and under the same conditions. This rope has a straight loose strand, consisting frequently of only a few yarns running through its centre; the object of this core-piece being to render the rope solid. 7. *Third lay*, or *cable-laid* rope. This consists of three hawser-laid ropes, each formed of three large strands, twisted or laid together in one gigantic rope or cable.

A very important consideration is the benefit or injury which is derived from a large or a small quantity of tar, because this, instead of being a preservative in all situations, as is generally supposed, is very often injurious, as is fully illustrated by the following experiments. The abridged account of these is taken from Sir D. Brewster's "Edinburgh Encyclopædia."

It was long ago shown by Dr. Hooke, from several experiments on the strength of cordage in 1669, that the strength of the component parts of the rope was diminished by twisting. This fact, indeed, has been long practically known to sailors, who are familiar with the superior strength of rope yarns when made up into a *salvage*, which is nothing more than a skein without twisting. Salvages are invariably used for slinging great guns, rolling tackles, and for every kind of work where great strength and great pliancy are required.

In the "Memoirs of the Academy of Sciences," M. Reaumur has given an account of his experiments on the strength of ropes compared with that of their parts.

2. The yarn of a skein of white thread bore each, at an average, 9¾ lb.
Two yarns twisted slack into a cord broke with 16 lb.

Hence we have the absolute strength of two yarns	19½ lb.
Real strength	16
Loss of strength by twisting	3½

3. The average strength of some thread was such that each broke with 8 lb., whereas when *three* were twisted, they bore only 17½ lb.

Hence we have absolute strength	24 lb.
Real strength	17½
Loss of strength by twisting	6½

4. The average strength of some thread was such, that each broke with 7½ lb., whereas when *four* were twisted they broke with 21½ lb.

Hence we have absolute strength	30 lb.
Real strength	21½
Loss of strength by twisting	8½

5. The average strength of other four threads was such that each broke with 9 lb., whereas when twisted, they broke with 22 lb.

Hence we have absolute strength	36 lb.
Real strength	22
Loss of strength by twisting	14

6. A well made and small hempen cord broke in different places with 58, 63, 67, and 72 lb., so that its average strength was $\frac{58+63+67+72}{4} = 65$ lb. The cord consisted of three strands, and another part of it was untwisted, and its three strands separated. One of them bore 29½, another 33½, and the third 35.

Hence the absolute strength of the three strands, when separated, is	98 lb.
Real strength when twisted	65
Loss by twisting	33

7. Another part of the same cord, which broke with 72 lb., was separated into its strands, when they bore 26, 28, and 30 lb.

Hence we have absolute strength	84 lb.
Real strength	72
Loss by twisting	12

Dr. Robison has given an account of a very interesting experiment by Sir Charles Knowles, upon a piece of of white or untarred rope 3½ inches in circumference. It was cut into many portions, and from each of those portions a fathom was taken off, and carefully opened out. It consisted of 72 yarns, each of which was examined separately, and found to bear 90 lb. at an average for the whole Each piece of rope corresponding to these was examined separately, and the mean strength of the same pieces was 4,552 lb.

Hence we have absolute strength of yarns	6,480 lb.
Real strength	4,552
Loss of strength by twisting	1,928

As the diminution of strength in the yarns demonstrated by the preceding example, obviously arises from their position when twisted, in consequence of which they do not all bear the load at the same time ; and not from any permanent weakness produced by the twisting, it became reasonable to believe, that the twist given to ropes should be as moderate as possible.

The degree of twist commonly employed was such that the rope was *two-thirds* the length of the yarns which composed it. M. Du Hamel,* who made many valuable experiments on this subject, in the royal dock-yards of France, caused some rope to be worked with only *three-fourths* of the length of the yarn. This last rope with the inferior degree of twist, bore 5,187 lb., whereas the other bore only 4,321 lb. He next caused these ropes to be made with different twists, and obtained the following results :—

	Weight borne by each.	
Degree of twist.	One experiment.	Another experiment.
⅔	4,098	4,250
⅘	4,850	6,753
⅘	6,205	7,397

* 'Traité de la Fabrique des Manœuvres pour les Vaisseaux, on l'Art de la Cordiere perfectionée.'

So far these experiments were highly satisfactory; but it still remained to be seen, whether or not the ropes which had an inferior degree of twist, had not also an inferior degree of useful solidity, notwithstanding their superiority of strength in carrying weights.

In order to determine this point, M. Du Hamel had a considerable quantity of rigging made with yarns wrought up into only *three-fourths* of their length, and got them put into actual use on ship-board, during a whole campaign. The report given by the officers of the ship was highly satisfactory. They proved that the ropes thus manufactured were *one-fourth* lighter than the common kind; that they were nearly *one-eighth* more slender, so as to give less hold to the wind; that, from their being more pliant than the common ones, they run easier through the blocks, and did not run into what are technically called kinks; that the new cordage required fewer hands to work it, in the proportion of *two* to *three;* and that it was at least *one-fourth* stronger.

Wherever ropes are not exposed to short bendings, as in the case of standing rigging, where they can be defended from water by tarring, &c., the least twisted cordage may be advantageously employed, and should, according to M. Duhamel's experiments, be made from strands; for it is demonstrable that in fine stranded cordage, when the twist of the strands is exactly equal to the twist in the laying, the strands lie less obliquely to the axis than in other ropes, and therefore bear a greater load.

In examining the strength of cordage, 3½ inches in circumference and under, M. Duhamel found that the strength increased a little faster than the number of equal threads, thus :—

Ropes of 9 threads bore	1,014,	instead of 946 lbs.
12	1,564,	1,262
18	2,148,	1,893

According to the experiments of Mr. Huddart, no strength is lost in the common way when there are only three yarns in the strand. When there are more than three yarns, the loss is one-sixth, and with a hundred yarns it is about one-half.

The following rule is given by Dr. Robison for obtaining the strength of ropes :

Multiply the circumference of the rope in inches by itself, and the fifth part of the product will be the number of tons which the rope will carry.

For example, if the rope is 6 inches in circumference, we have 6 times 6, = 36, the fifth of which is 7⅕ tons.

Tarring Ropes.—There is no branch of the rope manufacture more important than that which relates to the tarring of the cordage. The following experiments were therefore made by M. Du Hamel, on the relative strength of tarred and white or untarred cordage :

August 8th, 1741.

Untarred Rope.	Tarred Rope.	Difference.
Broke with 4,500 pounds	3,400 pounds	1,100
4,900	3,300	1,600
4,800	3,250	1,550

April 25th, 1743.

Broke with 4,600 pounds	3,500 pounds	1,100
5,000	3,400	1,600
5,000	3,100	1,900

September 3rd, 1746.

Broke with 3,800 pounds	3,000 pounds	800
4,000	2,700	1,300
4,200	2,800	1,400

The ropes with which the preceding experiments were made, were three French inches in circumference, and were made of the best Riga hemp.

M. Du Hamel next examined the relative strength of a parcel of tarred and untarred cordage, which had been manufactured on the 12th July, 1746. It had been laid up in the store-house, and the following results were obtained at the dates mentioned:

	Difference of time in Months.	Untarred rope.	Tarred rope.	Difference.
		Pounds.	Pounds.	Pounds.
1746. April 14th	....	2645	2312	333
1747. May 18th	11	2762	2155	607
1747. October 21st	6	2710	2050	660
1748. June 19th	9	2575	1752	823
1748. October 2nd	4	2425	1837	588
1749. September 25th	12	2917	1865	1052

From these results M. Du Hamel concludes:—

1. That *untarred cordage* in constant service is *one-third* more durable than the same when tarred.

2. That *untarred cordage* retains its strength for a much longer time when it is kept in store.

3. That *untarred cordage* resists the ordinary injuries of the weather *one-fourth* longer than when it is tarred.

These results of direct experiments have been confirmed by the observations of seamen; but they have invariably found that untarred cordage is weaker than tarred cordage, when it is exposed to be alternately wet and dry; that tarred cordage is chiefly useful for cables and ground tackle which must be constantly soaked in water; and that cordage *superficially tarred*, is always stronger than what is thoroughly tarred, and resists better the alternate conditions of dryness and wetness.

Several important experiments on the relative strength of tarred and untarred ropes were made by Mr. W. Chapman*, chiefly with the view of determining the effects of his method of preserving ropes with purified or washed tar. Three pieces of rope were made on the 10th of August, 1808, of 12 threads in each strand. The first was an untarred rope, the second a rope made of washed tarred yarn, and the third a common tarred rope. A part of each of these ropes had their strength tried on the breaking machine; and another part was steeped in water for about three months, and then taken to a foundry stove, which is supposed to have been at about 130° of Fahrenheit. They remained in the stove above three months. After that they lay at Mr.

* Author of "Treatise on the progressive endeavors to improve the Manufacture and Duration of Cordage," London, 1808.

Chapman's ropery till November 3, 1803, when the following experiments were made with them :—

	When made, Aug. 10th, 1802.	Nov. 3, 1803.	Portion of original strenth retained.
	Cwt.	Cwt.	Cwt.
White rope	33.4	1.09	5.7 }
Common tarred rope	22.2	7.35	33.0 } per cent.
Washed tarred rope	29.1	12.35	43.8 }

The tarred ropes were both brittle; but the latter was more so, and they both cracked on bending.

Mr. Chapman has also observed that though cordage is injured by tarring in cold climates, it is much more rapidly so in hot climates.

The following experiments were made in 1807 by Mr. Chapman, for the purpose of showing the injury arising from the retention of that portion of the essential oil which cannot be dispensed with, and also the injury which arises from the progressive disengagement of the acid of essential oil:

	Weight with which it broke when moist.	Weight with which it broke after exposure to a stove for four months.
	Cwt.	Cwt.
Untarred rope	45.75	38.97
Rope tarred with cold tar	51.29	26.40
Rope tarred with boiled tar	38.94	25.07

The first column shows the strength of the rope when made; and the second after having been exposed to the heat of a stove from 85° to 100° Fahrenheit.

The following experiments, also made by Mr. Chapman, confirm those made by Duhamel, respecting the diminution in the strength of cordage produced by tarring. The ropes were registered on the improved principle, and were made with the same yarn, and with 17 threads in each strand.

	Girt in inches.		Comparative strength.
		Cwt.	Cwt.
1806. October 2, White rope	2.75	Broke with 75	100
1806. October 24, Tarred rope	2.8	" 55	73.3
1807. May 8, Same rope	2.8	" 41.4	55.2

The following experiments were made with ropes made of the same yarns, and of nine in each strand.

	Girt in inches.		Comparative strength.
		Cwt.	Cwt.
White rope	1.7	Broke with 27. 5	100
Tar of whale oil	1.85	" 22. 5	83.7
Tar and tallow	1.8	" 17. 5	63.6
Tar unpurified	1.7	" 15.95	57.7

Whale oil and tallow have therefore an excellent effect, particularly the former.

The following experiments were made by Mr. Chapman on the elasticity of ropes of different kinds, when strained with seven-eighths of their breaking stress :

	Original length.	Length when strained.
	Inches.	Inches.
Registered primary strands	24	24¾ to 25
Registered shroud laid ropes	24	26 to 26½
Common made shroud laid rope	24	27½ to 28
Registered cable laid rope	24	27 to 27½

The three kinds of rope last mentioned stretched on an average 1 inch in 24 with a fifth of their breaking stress, which is from ½ to ⅔ lb. of the whole stretching of the registered shroud laid ropes, but only from ⅔ths to ¼th of the stretching of the common made shroud ropes.

In May, 1805, Sir Joseph Banks, being anxious to try teak tar for ropes, two three-inch ropes were made of the same yarns, one with teak tar, and the other with common tar. They were then placed in the same storehouse, and were broken Sept. 28th, 1807. Common tarred rope broke with 3,848 lbs.; That made with teak tar broke with 5,980 lbs. The common tarred rope being only about *two-thirds* the strength of the other.

APPENDIX.

It will be interesting to make some extracts from the valuable report of the Commission appointed under an Act of Congress approved February 25th, 1863, "for investigations to test the practicability of cultivating and preparing flax or hemp as a substitute for cotton."

All European writers recommend the harvesting of flax to be done by pulling. This process is considered in America to be slow, tedious, and expensive; and where flax is grown on a large scale by individual proprietors, it is impossible to procure the labor necessary to pull it. They, therefore, have recourse to machinery, and the improved harvesters are adjusted so as to cut the crop close to the surface of the ground. Several pulling machines have, also, been invented, which do their work more or less satisfactorily.

"The annual production of hemp fibre in the United States, as reported in the last census, amounts to eighty-seven thousand one hundred and ninety tons, of which eighty-three thousand two hundred and forty-seven tons were dew-rotted, and only three thousand nine hundred and forty-three tons were water-rotted. There is a decided preference among the manufacturers for the water-rotted material, and the navy regulations indicate that experience considers this the preferable mode of preparation. But few of our farmers are willing to take the trouble to adopt this process; indeed few have the necessary skill and appliances; but it would be performed to much better advantage by those who make it their especial business, and who have prepared suitable vats for the purpose. Some of our correspondents in Illinois appear to have made extensive vats, with the expectation of rotting largely. This is a suitable subdivision of labor.

"From the kindness of Mr. H. F. Driller, assistant secretary of the Board of Trade at the Merchant's Exchange, St. Louis, we have learned the product of hemp in that State for three years to be as follows:

In 1862, arrived at this port	88,720 bales.	
" arrived at other ports, about	22,100 "	
Total		110,820 bales.
In 1863, arrived at this port	68,131 bales.	
" arrived at other ports	17,000 "	
Total		85,131 "
In 1864, estimated at this port	74,150 bales.	
" estimated at other ports	20,100 "	
Total		94,250 "
Total in three years		290,201 bales.
Average per year		96,733⅓ bales.

"Kentucky and Missouri are the two leading States in which this crop has always been of considerable importance.

"Farmers generally complain of hemp that it is a hard crop to deal with, on account of the manual labour which it requires, but it is also urged that it is uncertain in its results because of the fluctuations of the market value. Its chief value is for cordage, bagging, and sail-cloth, but the fibre is very similar to that of flax; the ultimate cells are almost identical under the microscope, and it is applicable to the preparation of linen cloths. The manufacture of bagging and bale-rope in Kentucky having been mostly suspended, since the withdrawal or suspension of the demands of the cotton-fields, the extent of the crop has also been diminished, and the fibre has been largely worked into tow, and shipped in the bale to eastern and European factories.

"MACHINERY.

"When they were considering the subject of treating the flax-straw by any of the chemical operations to which it has been subjected for the purpose of aiding the separation and preparation of the fibres, whether these consisted of dew-rotting, water-rotting, or other more scientific or more elaborate processes, the commission endeavoured to set forth the great importance of a proper sub-division of labour, so that the farmer, with his manifold and pressing cares, might be relieved from the responsibility of conducting these delicate operations, for which, indeed, he is not always qualified. Here again we desire to urge upon those engaged in making arrangements for further treatment of the material by the mechanical handling of the straw, and its conversion into the beautiful fibre, the great advantage that will result from a separation of these duties from those appropriate to the farm. Indeed it is so apparent to us that the rotting and breaking of flax are truly manufacturing processes, required skillful labour and experienced management, that the continuance of their assignment to the farm labourer can only be viewed as a remnant of those peculiarities of the early stages of civilization which are here and there found to cling to us in an advanced condition of society. In former times the farmer, with the assistance of his family, was obliged to produce the raw material, to prepare it for manufacturing, to spin, and to weave it upon his own premises; but as we advance from such a primitive condition, the better subdivision of labour is progressively introduced, and we believe, as stated on a previous page, that the farmer's duty should always end with the harvesting of the crop, the separation of the seed, and the delivery of the straw to the manufacturer. In portions of Belgium, to which country we may well look for the highest degree of development in the preparation of flax, since there the finest fabrics are produced, we find that the ownership of the crop is transferred from the agriculturist to the manufacturer as soon as its prospective value can be safely estimated, and this is immediately after it has blossomed in the field; so that the farmer's duties and interests terminate at a still earlier period than that we have recommended to our countrymen.

"Notwithstanding our urgent desire for a proper subdivision of the labours of the production from those of the preparation of flax, and other textile plants, we know that in many parts of the country, where flax and hemp may be profitably grown by the farmer, the mechanic has not yet made his appearance with the needed machinery for operating upon the product. Indeed, the raw material is not to be found in sufficient quantities to justify the erection of large establishments for its preparation in many regions where it is and should be grown. Therefore we congratulate those isolated farmers who may be induced to cultivate this class of crops upon the fact that our ingenious mechanics have already provided for their wants by inventing and erecting farm machines, of moderate capacity and reasonable expense, which will enable individuals so situated to utilize their products, and put them into a condition that will bear transportation to market, or that will readily prepare them for home consumption.

"The most successful application of machinery to this subject that we have seen, is the arrangement of fluted rollers, with an oscillating motion backward and forward, but advancing more than it retrogrades. This is the Mallory & Sanford machine, which they call 'a portable flax and hemp dresser.' Owing to the peculiar form and motion of the rollers, the boon is crushed into shives of less than a quarter of an inch in length, and the harl is rubbed off from the straw with very little breaking of the filaments, while at the same time the shives are nearly all shaken out of the flax, which is broken and scutched at the same operation, and appears to need very little after scutching to finish it. This machine saves a great deal of fibre; indeed, there is scarcely any found with the shives, which are nearly clean, instead of being, as they are often seen, a tangled mass of filaments and shives about the brakes.

"The latest modification of this apparatus, wherein the rollers are arranged in a vertical series fed from above, was tested in the presence of the commission with very

satisfactory results, and they do not hesitate to declare that the work was performed rapidly and well. The apparatus was new, and therefore some allowance should be made for its working capacity. The large machine is said to require a driving force equal to two horse-powers, and its capacity for work is estimated at one and one-eighth tons of straw per day. The makers of this machine in its later or upright form, with a succession of fluted rollers placed horizontally and set one above the other, when they use two breakers and one finisher combined, all feeding from above, claim that they can produce one thousand pounds of clean fibre per diem, with the assistance of four hands to the brakes, one hand to scutch, and two boys to assist.

"As originally constructed, we have heard it objected to these machines that their mechanism involved a hard motion, and apprehensions were felt that the machinery might give way. At an establishment in Pennsylvania, it was stated that four scutchers were needed to cleanse the fibre produced by three workmen, running three thousand pounds of straw each day through one machine. We cannot help thinking that this result, so different from our own observations, and from the testimony of many practical workmen who have adopted these machines, must have arisen from a want of experience in the labourers, and from their attempt to put through too much straw; and that, had they attempted to break less, they would have found the scutching a small matter, with revolving knives.

"Messrs. Mallory & Sanford's machines have been recommended for breaking straight straw for tne preparation of long-line, and as being equally well adapted for the breaking of the most tangled flax, that it comes from the threshing floor. It is also claimed that they will separate the shives from green or unretted straw more perfectly than any other apparatus. Specimens on exhibition, and others broken in our presence, are entirely satisfactory evidence that such breaking can be done where desirable. though at the expense of a partial rupture of the filaments themselves, which, in the preparation of long-line, would be productive of a larger percentage of tow or tangled fibre than results from the handling of properly retted straw.

"In the preparation of short fibres this partial rupture of the filaments is a matter of no consequence, but, on the contrary, the breaking without previous retting, and its attendant straining of the fibre, is considered a great desideratum by those who desire to manipulate the fibres in their processes of cleansing and disintegration to which they subject this material in preparing it for spinning upon cotton machinery. It is found much easier to bleach and prepare the fibres of unretted, than those of retted straw, and the result is much more satisfactory.

"Before dismissing the consideration of the Mallory and Sanford machines, which have given the commission such satisfactory results, and which present great encouragement to our farmers who have heretofore been deterred from flax-growing by the labor attendant upon the preparation of the fibre, the commissioners desire to mention an additional appliance to those brakes, by which the most tangled mass of straw has its stalks straightened out, and presented to the fluted rollers at a right angle, so as to be most perfectly acted upon in its passage through the machine. By this means the efficiency of the brakes, when acting upon tangled straw, is greatly increased.

"Scutching consists in separating the loose shives and dirt, but also results in the removal of a considerable portion of the fibre, as coarse tow; the first exposure of the broken flax to the scutching knives removes the most of the shives and makes the coarse tow; the second scutching gives a more valuable tow product; but the next or heckling process produces the fine tow, which consists of the tangled and broken filaments that are combed out of the streiks of flax as they are subjected to this instrument. Heckling is almost exclusively done by hand. Heckled tow contains very little shives.

"Rowan's scutcher is a series of metallic beaters which revolve with great rapidity on the periphery of a drum, in close proximity to a breast or plate of iron, over which the workman holds the streik, so as to expose the ends alternately to the beating process. The work is done rapidly, and the cleaning is very well performed, but with the production of a large amount of waste tow. This machine is also used as a brake, but appears to waste a great deal of fibre, which falls with the shives. The advantages of this machine are, small space occupied, and rapid work.

"One of the most promising scutching arrangements we have seen is that of a model of Mallory & Sanford, which consists of a vertical drum four feet in length, composed of clamps for holding the streiks of flax. These are made to revolve very rapidly after

being charged with the fibre. The centrifugal force beats the flax against the edge of an upright scutching board that is fixed near the periphery of the revolving drum of clamps. When the ends of flax are cleaned the machine is stopped, the clamps are removed, loosened, and the flax is shifted so that the other ends of the streiks shall be exposed to the scutching process. It was found in experiments before the commission that this machine, with one scutching-post, would clean both ends in fifty seconds, and by applying four upright scutching boards, and four clamps to each drum, it was estimated that the whole charge would be cleaned in half a minute.

"In confirmation of our favourable impressions of the Mallory & Sanford machines, we subjoin some extracts from the report of the special committee on flax machinery of the New York State Agricultural Society. This committee report:

"'That they carefully examined the machine presented by Messrs. Mallory & Sanford, New York, and tested it under a great variety of circumstances.

"'Experiment 1st. Ten pounds three ounces of unretted straw, precisely as it came from the field, was passed through the breaking machine. The time occupied was two minutes fifty seconds, and the weight after breaking was six pounds ten ounces. The scutching process occupied six minutes, and the flax weighed after scutching just two pounds.

"'Experiment 2nd. Ten pounds of half retted flax (dew-retted) was passed through the breaking machine; the time occupied in the process was two minutes fifty seconds, and the flax weighed five pounds. It was scutched in nine minutes and twenty seconds, and weighed two pounds three ounces.

"'Experiment 3rd. Twenty-one pounds one ounce of thoroughly retted (dew-retted) flax straw were passed through the machine in three minutes fifty seconds, and weighed nine pounds. The broken straw was scutched in eight minutes thirty seconds, and weighed four pounds fourteen ounces. With the ordinary facilities of a factory, two men could do with ease what it required four men to do at the trials.

"'The average work of the machine during these three trials was 1,158 ounce per second, which at ten hours work per day would be equivalent to 2,668 pounds of flax straw.

"'The total weight of broken straw in these three experiments was twenty pounds ten ounces, which was scutched in twenty-three minutes fifty seconds, which is equal to 0.772 ounce per second. Running steadily for ten hours, a scutching machine will dress 1,737 pounds of broken flax-straw.

"'It, of course, would be difficult to work the machines regularly as fast, or to do as much work with them as was done at these trials, but we have no doubt that the brake could run through 2,000 pounds of straw daily, and that two scutching machines would dress the flax as fast as it was broken by the first machine. Six-horse power would probably be amply sufficient to run the brake and the two scutchers.

"'The unretted flax in these experiments yielded 18.9 per cent. The half-retted yielded 21.9 per cent. The well-retted yielded 23.1 per cent of dressed flax.

"'The day devoted to these experiments was a very rainy one, and the straw had lain upon the ground for several hours; it had, therefore, imbibed much moisture, and was in a very bad condition for dressing. If the experiment had been tried in a clear, dry air, much better results would have been obtained.'

"In conclusion they say:

"'1st. That the machine of Mallory & Sanford does more work, with less power, than any other.

"'2nd. That it detaches more of the worthless from the valuable portions of the straw than any other.

"'3rd. That it wastes less of the fibre. On a careful examination of the shive after the experiments, we could not detect a single particle of the fibre.'

"'4th. It is cheap and durable and not dangerous to either life or limb. The cost of the largest machine is 35; the second size, $255; the third, $155.

"'5th. It does not require skilled labor to operate it. This remark applies to the brake, and not to the scutcher.

"'6th. It requires but a very small space: the largest size occupies but four feet square and weighs 1,100 pounds.'

"McBride's machine is in operation at Delaware, Ohio; as a scutcher it is very efficient and ingenious. The flax is applied in the bite or twist of a double, endless rope, which receives the streik at one side, carries it through the scutcher, where it is well dressed throughout; during its passage, the rope shifts its hold of the flax by the torsion action, so that all is scutched and delivered to the workman at the other side of the machine, who lays away the bundles of clean flax. This machine will dress from four hundred to six hundred pounds a day.

STATEMENT.

"I herewith beg to submit my treatment of converting flax into a cottonized substance:

"I commence by taking the flax straw gathered *when fully ripe*, either *tangled* or *straight*, after the seed has been taken off. The straw, after being air-dried, is passed through a flax breaker, of Sanford & Mallory's make. By the operation of this machine the boon, or bark, is, to a considerable extent, separated from the fibre, and the stem loses about fifty per cent. of its original weight and reduced to one-half of its original bulk. After breaking it is put through a picker and duster, by which a large portion of the adherent portions of wood are removed. The fibre is now ready for boiling. The boiling consists of the following process:

"To every ton of the fibre add as much water as will well cover it, and afterwards introducing into it about five per cent. of a solution of caustic soda of the specific gravity 1.50°. (The caustic soda is made by adding caustic lime to a solution of soda ash in the proportion of two parts of lime, six parts of water, and two of soda, and twelve parts of water. This is the *concentrated* liquid). The fibre is allowed to boil three hours, and then is passed into a solution of carbonate of soda of five per cent.; then into a solution of sulphuric acid of one and a half per cent.; then into a solution of soda ash, same strength as before. It is then partially split and ready for bleaching.

"The bleaching liquid is hypochloride of magnesia, made by taking one part by weight of chloride of lime to twelve parts of water; and in a separate vessel, two parts of sulphate of magnesia to twelve parts water. Mix the two solutions together, the clear liquid is then diluted to 3° Twaddle, specific gravity 1°.015. When sufficiently bleached, is then removed to a solution of carbonate of soda, same strength as before, and left there half an hour; then passed into a solution of sulphuric acid, same strength as before, and allowed to remain there as long as any disengagement of gas is visible; then wash the fibre in a weak solution of oil soap. It is then dried by passing through a wringer and passed over heated copper cylinders to the picker and duster. It is then carded on a Dundee card, and is finished by passing through a 48-inch wool card. The time occupied in the operation of boiling and steeping process to the state ready for carding, is six hours.

"The expense of converting one ton of flax straw into flax cotton is as follows:

One ton of flax straw	$10 00
Breaking one ton of straw	2 50
Picking and dusting 1,000 pounds	1 00
Boiling in caustic soda 570 pounds	2 50
Labor in steeping and chemicals	16 00
Washing and drying	2 00
Picking and dusting 354 pounds	50
Dundee carding	50
Carding on wool cards 291 pounds, producing 257 pounds	5 00
Total cost	40 00

Or less than sixteen cents a pound, exclusive of rent, interest and insurance, which the bleached flax waste will cover. It has been sold to paper makers at four and a half cents per pound. The shives and other waste are used for fuel under boilers.

Cost of machines and vats.

Breaker	$355 00
Picker	175 00
Duster, or willow	150 00
Picker for white stuff	250 00
Dundee card	750 00

Wool card for finishing	1,100 00
One boiling iron vat	150 00
Six wooden vats	300 00
	$3,230 00

"The recent advance in the price of chemicals has raised the cost of production.

"I adopt the Claussen process, having purchased the right for the use of his patent for the United States, having practically experimented upon it, and fully demonstrated the most favourable results. In 1854 I commenced manufacturing flax cotton at Rocky Hill, New Jersey, and produced a sufficient quantity on a commercial scale to induce a number of gentlemen to form an organized company, with a capital of $200,000; but from the low price of cotton and wool at that time, and the unfavorable state of the money market, and the prostration of the manufacturing interest, and from the prejudices of manufacturers to use a new staple, they became discouraged, and from some of the shareholders not paying their full instalments of shares, the company disposed of their property after having produced about ten tons of flax cotton. Most of it was purchased by Messrs. Lawrence & Stone for their manufactory at Lowell.

"I can prove from practical experience that flax and hemp can be converted into a fibre stronger than cotton or wool, and capable of taking better color than either; can be spun and wove on the existing cotton and woollen machinery at a cost below cotton or wool at any time, there being less waste. It will mix and felt with wool, having had it mixed with wool and made into cloth and hats, and I had them worn in my family and found them much more durable than all-wool.

"There has been a great deal of prejudice against some portions of Claussen's process totally unfounded and misconceived. For instance, that it was not suitable for making long flax, but rather that *all*, long and short, indiscriminately, was converted into flax cotton; the fact is the reverse. No doubt the flax cotton is the greatest novelty, a new article of commerce, and so becomes the most prominent feature in the various inventions. The long flax, however, through Claussen's process, is produced in better condition than as at present for the manufacturer, and what is indifferent and not sufficiently well grown for long flax is quite suitable for, and is converted into, flax-cotton, also common tow, and such like stuff. By this process the flax, instead of being pulled in a green state, is allowed to ripen the seed, and can be cut with a mowing machine. The farmer by this means saves the great expense of pulling, and has the seed, which alone pays for raising the crop, and by breaking the straw with a hand machine, such as Sanford & Mallory's, he can return to the land nearly one-half the weight as manure. The shives contain silica, and by feeding his cattle the refuse seed and bolls, he also obtains a rich manure. In 1854 I had an agent in Washington exhibiting specimens showing the whole of Claussen's process, from the flax straw to the finished cotton, linen, and woollen fabrics, in a bleached, unbleached and dyed state.

Yours respectfully, H. McFarlane.

FOURTH SUBDIVISION, OR MANUFACTURING STAGE.

"A leading object of the appropriation having been to test the practicability of substituting the fibres of flax for cotton, on cotton machinery, and also of mixing them instead of cotton with wool, we have directed our attention particularly to such modes of assimilating these fibres to cotton as would, in our judgment, be likely to accomplish the desired results, and to such modifications of cotton machinery (wool machinery not requiring any changes) as would best adapt it to the production of yarn from such assimilated fibres. We have not deemed it necessary to give much time to the mechanical modes of long-line flax-spinning now in general use in European countries, as the raising of marketable flax for long-line imposes too many burdens on the growers, and is produced at too great a sacrifice of seed to warrant, at present, its extensive cultivation in this country. Both the raising of flax for long-line, and its manufacture by machinery where grown, seem to be better adapted to countries of humid climates, and of comparatively small areas for cultivation, subdivided among a dense population accustomed to cheap manipulating labor. There are very few mills of this kind in the United States, and most of these are using long-line for coarse fabrics, obtained to a considerable extent in the Canadas, whence it is imported free of duty under the reciprocity treaty. A member of this commission recently visited one of these mills at Braintree, Massachusetts, and was shown the various machines and processes for making

coarse, long-line yarn and cloth. It is well known that the only mill of this class in our country fully equipped for spinning and weaving fine long-line yarns, (located at Fall River, Massachusetts), was, after a great outlay of capital and immense exertions to operate at a profit, converted into a cotton mill at a heavy loss, in consequence of an insufficient home supply, the mill being precluded from using foreign stock by a practically interdictive duty.

"After the most careful consideration of various modes of growing and treating flax to obtain the best results to the farmer, and an abundant supply to the manufacturer, we are of the opinion that the crop should be planted mainly for the seed, and incidentally for the fibre; that to insure the greatest profit to the grower from both these sources, there should be sown from four to six pecks of seed to the acre; that if the crop is designed for ultimate fibre, *i. e.*, flax-cotton, it should be harvested by machine cutting in the morning after the dew is off, when the seeds are sufficiently in the glaze to be of brown color; thereby securing the greatest supply of oil and the least rigid condition of fibre; that it should be exposed to the sun through the day, cocked towards night, and treated in other respects like grass cut for hay, avoiding as much as possible exposure to rain or dew; that the seed should be threshed in the cheapest and most convenient manner regardless of the tangled condition of the straw; that the latter should, for the effectual removal of the shives, be subjected to the action of approved power brakes, (we give the preference to Mallory & Sanford's twelve-roller kind), located either on the farms or at convenient points for the neighborhood patronage; that in this form it should be rough-baled and sold to chemical disintegrating works, to be there further divested of dirt and shives by mechanical means, and exposed to high steam in combination with mild or strong alkaline solutions for disintegration, and in this finished form sold as stock for manufacturing into fine linen fabrics on cotton machinery. Flax cotton from such stock will be reliable for uniformity of strength, and be sufficiently white without bleaching prior to its manufacture into cloth.

"But if the crop is designed for short stock to be manufactured on modified cotton machinery into coarse linen goods without chemical disintegration, we recommend retting the straw, and that on taking the flax from the brakes it be subjected to the further action of power disintegrating, shortening and cleaning machinery, to be located at convenient centres in flax-growing districts, and there be baled for the market.

"We are aware there is an impression that unretted straw cannot be successfully divested of its shives by mechanical means. This impression is probably based upon the imperfect mode hitherto practiced in harvesting the crop. The straw, even if intended to be left in an unretted state, is generally permitted to lie more or less exposed to dew or showers a few days after cutting. This partial wetting and drying appears to have a tendency to crystallize the gluten or cellulose between the filaments and woody portions, which makes it more adhesive and harder to separate; but if the straw is harvested and dried without exposure to moisture, the crystallizing process not being developed, we think the shives will, under the action of properly constructed brakes, readily separate from the fibres. We have seen unretted, tangled, as well as straight straw, quite thoroughly divested of shives after passing twice through a single head of Mallory & Sanford's brake, with the horizontal, rotating and vibrating rolls, placed in sets one above another.

"It is estimated that retted straw shrinks in weight about fifteen per cent., while the fibre loses very little of its weight. This is caused by the partial decomposition of the shives and a portion of the gluten or intercellulose; so that if the straw crop is sold in an unretted state a proportional allowance should be made for its extra weight, less the value of the unretted shives for cattle-feeding, which is said to be considerable, as their oleaginous properties make them quite nutritious. A ton of retted straw in good condition produces about 450 pounds of flax, while a ton of unretted produces only about 380 pounds. Good retted straw in ordinary times is worth, in flax districts, say eleven dollars per ton of 2,000 pounds, equal to 2½ cents per pound for the flax. This gives a proportional value of nine dollars per ton for unretted straw, equal to 2½ cents per pound for each kind of flax. The cost of labor, supplies, power, supervision and use of machinery and buildings for converting the straw into flax, is also about 2½ cents per pound; making the entire cost of the flax at the brake machines five cents per pound. This, if sold at seven cents, in ordinary times would give a liberal profit to the proprietors of such machines; but flax in this form will, of course, be subjected to a diminution in weight when further divested of its glutinous substance, straggling shives and seed-ends, by the action of preliminary machinery for converting it into filaments

and fibres of the requisite fineness and length to be spun into coarse yarn, which with the loss of short fibre in manufacturing, and tare of the bags and ropes, will be fully equal to twenty per cent. of its weight, thereby adding two cents per pound to the first cost; to which must also be added 1½ cent per pound for railroad and mill transportation and other expenses, making the entire cost of the stock in ordinary times at the consuming mills about 10½ cents per pound.

"The same stock sold from the brake machines at seven cents per pound to the proprietors of mechanical and chemical disintegrating works, to be "cottonized" for yarn suitable to weave into print-cloths or shirtings, would be subject to a loss in the respective processes of about forty-five per cent. of its weight, thereby adding about 6½ cents per pound to the cost; to which must also be added 1½ cent per pound for railroad and works transportation and other expenses, making the cost at the works thus far fifteen cents per pound. The cost of cottonizing, including the preliminary mechanical operations at the works, will be about four cents per pound net weight, making the entire cost at the works in ordinary times, exclusive of any charge for profit, about nineteen cents per pound.

"If any of the manufacturing trade should be apprehensive under this estimate that the difference in value between flax-cotton and cotton in ordinary times would discourage the use of the former, no matter how perfect the stock may be prepared, we would remind such, that if linen goods continue to maintain their supremacy in the market, print-cloths or shirtings made of flax cotton would probably command a price that would leave a larger difference in favor of the manufacturer than the difference of cost between the two kinds of stock.

"In the early stage of the effort to cottonize, there was a general belief among experts (including the Chevalier Claussen, and also Mr. Sands Olcott, of Pennsylvania, the pioneer in this country of flax-cotton, and who patented a flax-straw cutting machine in 1840) that it would be necessary to cut the straw into lengths comparing favorably with the length of cotton; but a critical and microscopic analysis of the constituent parts of the fibrous covering of the straw revealed the fact that the filaments of which it was composed were subdivided into cells or individual tubular fibres, of nearly uniform fineness, and somewhat variable lengths, cemented longitudinally by intercellulose, or gluten, which, while it would to a great extent resist the disintegrating power of machinery, could not maintain its cohesion against the liberating and dissolving power of tepid-water soaking, followed by long-continued boiling in mild alkaline solutions and subsequent exposure for a short time to high steam; or by boiling at a temperature of 280° Fahrenheit, with soda-ash or caustic solution, without any preliminary processes.

"It then became a question to what degree of fineness and maximum and minimum lengths of fibre can flax be safely reduced by mechanical means only; and in what way can the product of such means be successfully spun into coarse yarn on cotton machinery? These questions have been met by the owners of a number of cotton mills in various parts of the country that have heretofore been employed in manufacturing the lower and coarse grades of cotton goods. Some of these mills, especially those that are located in flax-growing regions, began with tangled straw, and carried it successfully through draught-roller brakes, dusters, and wool and cotton pickers, thereby preparing their own stock; while others situated remotely from such districts have preferred purchasing their supply in bales, of parties residing there who have made the preparation of such stock a special business. The latter mode of obtaining it, besides being in accordance with the views of the commission, seems best adapted to encourage the alteration of this class of cotton mills into flax mills; and also for supplying flax disintegrating works with material to be transformed into flax-cotton for use by a higher class of cotton mills in the production of fine linen goods.

"In determining the question of length of stock by means of preparatory machinery, it has been found impracticable to obtain, by any combination of machines yet employed, maximum lengths of fibre less than about three inches, without reducing the minimum lengths shorter than the fibres of cotton; and hence it became necessary to depend for the further reduction of the maximum lengths upon modifications of the machinery at the mills as arranged for cotton. To this branch of the subject the commission has given much attention, but as a report of our investigations is expected in time for distribution soon after the closing of the present Congress, we have reluctantly suspended our labors without obtaining as full results as the magnitude of the inquiry

calls for, or as the light already obtained promises. We did not think it desirable at the commencement of our labors, while the manufacturers of both flax and cotton as well as ourselves were in a comparatively undeveloped state, to use the appropriation in crude experiments, or expenditures that might result only in loss. We preferred, as far as possible, to avail ourselves of the incipient efforts of those whom patriotism or hope of securing monopolies had stimulated to attempt the solution of the cottonizing problem. To this end, two of our commission visited in the past autumn nearly all the points in the western and eastern portion of the country, and in the Canadas, where particular attention had been given either to the growth or manufacture of flax. From these visitations and conferences, to which have since been added our own experiments, we have reached conclusions both in regard to the most promising modes of using flax cotton prepared exclusively by mechanical means for the manufacture of coarse goods, and by combined mechanical and chemical means for the manufacture of fine goods on cotton machinery, which we will now proceed to delineate, premising that if the unexpended balance of the appropriation is devoted to further discoveries by this or a new commission, the results might be given in a supplementary report at the first session of the next Congress. We think this course preferable to a lapse by "non-user" of the unexpended part, and much more likely to result in a larger contribution of valuable knowledge to the public upon this highly national investigation than a distribution of it in small sums to the many enterprising parties in different sections of the country who have so courteously responded to our call for information, and who have so generously sent specimens of their various productions for the museum of the Department.

"Very good short flax stock is prepared from tangled straw for coarse yarn mills by Randall's, Clemens's, Smith's, and several other series of machines, but the cleanest and finest short stock that has come under our notice is that obtained from the Davies machine, made at Dayton, Ohio. This machine is composed of an iron or wooden frame, having a series of five open aprons, fluted feed rolls that rotate in iron shells, and wooden cylinders which have diameters of a foot each, and revolve about six hundred times per minute. The surface of the cylinders is perforated for the reception of square spring-tempered No. 12 wires, square at the ends, and inserted in the apertures in spiral rows converging from the heads towards the centres, and projecting from the surface about half an inch. The flax either in the straw (if retted) or in the form of crude tow is fed on a level apron through the feed rolls to the first cylinders, from which it is thrown on an inclined apron to be carried to the second set of feed rolls and the second cylinder, and then successively over the other inclined aprons, and through the other feed rolls, and over the other cylinders, until delivered at the end of the machine in bulk, when it is collected and baled in the same manner as cotton for the market.

"In this form it is carried into cotton mills and presented first to the lapper, no preliminary operations being required, as it is to a great extent free from shives, dirt, or other extraneous matter. But as this stock, notwithstanding its comparative cleanliness and the ease with which it is made into laps, is too coarse and uneven for the carding process, without modifying the lapper beaters to adapt them for shortening the long filaments and fibres and making all the fibres finer, we added to each of the beaters another set of arms, and attached at the ends in lieu of knives wooden lags two and a half inches wide. The fronts of these were covered with strips of leather two inches wide, into which were inserted curved and pointed teeth of No. 14 wire, with their points on the same periphery as the knives on the other arms, and which, when in motion, rotate within about one-eighth of an inch of the periphery of the feed rolls. The speed of the beaters, arranged in this manner, should be about 2,000 revolutions per minute. When the beaters are so equipped, they not only distribute the grist evenly on the wire cylinders and lap rollers, but if the laps are doubled and carried through the lapper a second time, they disintegrate the filaments so thoroughly as to largely increase their number, and at the same time materially shorten those that were of too great length for the subsequent operations in the mill, without visibly shortening those that were sufficiently short in the bale. The laps so prepared are next carried to the carding machines, the carding power of which, in a great number of American mills, is in a main cylinder, doffer, and top-flats, all covered with fine, chisel-pointed wire clothing, which, although well adapted for carding cotton, is considered insufficient for carding flax fibre. The insufficiency is caused by the fact that flax fibres have less elasticity and greater specific gravity than cotton, and are withal straight rather than curled like the latter, and hence do not rest easily upon the surface of the teeth, but are inclined to imbed themselves among the teeth, which makes it desirable to substitute

needle-pointed clothing for chisel-pointed on the main cylinders and doffers, and also to substitute working, stripping, and fancy cylinders for the top-flats, which should likewise be covered (except the fancy) with needle-pointed clothing. This form of the teeth permits the workers and strippers, aided by the long and flexible teeth of the fancy, to act freely on the main cylinder, keeping the stock upon its surface and ready for delivery to the doffer. If the chisel-pointed clothing, however, of the main cylinders and doffers is in good condition, and the stock is well prepared, it can be used in connexion with the working, stripping, and fancy cylinders, but the two former kinds must have needle-pointed clothing. The latter is always covered with long, fine, and flexible clothing. The surface velocity of the fancy cylinder should be about twenty-five feet faster than the surface velocity of the main cylinder; the workers and strippers should run at the usual speeds; and one worker and one stripper are sufficient for one card. The cards should have screens of perforated sheet zinc under the main cylinders, and the licker-in cylinders (if there are any) about three-eighths of an inch from their surfaces, otherwise too much of the stock will be thrown off in the form of waste by the centrifugal forces developed in the rotation of these cylinders. The feed rolls should be heavily weighted, and their speed be increased about twenty-five per cent. The stock may be carded once or twice. We think once is sufficient. In either case, the fleece should first be delivered into a railway trough; and, if intended for a second carding, the product or sliver should be collected from calendar rolls without being lengthened, and made into laps for the finishing cards, and from their railway should be drawn by means of a draught railhead from two and a half to three inches. This head should have three under rolls, one and one-quarter inch in diameter, placed about three and a half inches from centre to centre of the back and front rolls. The back and front rolls should be fluted or corrugated; the back top roll should also be fluted or corrugated, while the front top roll should be covered either with vulcanized rubber or gutta-percha, (the latter can be had at 153 Broadway, New York, of the Gutta-Percha Manufacturing Company), and both rolls should be one and one-half inch in diameter. The middle under roll should be encircled by a spring gill, with collars at either end, rising an eighth of an inch above the points of the gill needles; the back top roll should be slightly weighted, and the front top heavily. The entire draught should be between the gill roll and the front roll. The slivers from this head should be collected in cans, and passed through either one or two heads of a drawing frame, with gills on the middle under rolls, and with top rolls fitted like the top rolls of the railhead, doubling the slivers at the draughts, which should not exceed one inch into four. From the drawing frame the stock should be made into condensed and untwisted roving on a Taunton speeder, arranged with gills on the middle roll, and with top rolls similar to the rail and drawing frame heads. The spinning frames may have either rings or flyers for twisting. As good yarn can be had from one as the other, it is indispensable that the frames should have large rings or flyers designed for coarse spinning only, as the kind of stock we are treating of cannot at present be made into finer yarn than numbers ranging from six to ten, (cotton gauge), and it is wholly impracticable to think of spinning it on frames designed for yarn ranging between twenty and thirty-five skeins to the pound. The frames for this stock must be arranged with a draught not exceeding one inch into six inches, and should be fitted with spring gills on the middle rolls for each spindle, and with uncovered smooth iron back top rolls one and a half inch in diameter without weights. The front rolls should compare with the front rolls in the preceding operations. These spinning gills consist of twenty rows of tapering needles, seven-sixteenths of an inch long and one thirty-second of an inch in diameter at the base, six in a row, one-sixteenth of an inch apart, and inserted obliquely through apertures in a brass hollow cylinder one and seven-sixteenths inch in exterior diameter, and projecting through the surface four-sixteenths of an inch, making the entire diameter of the periphery of the points one and fifteen-sixteenths inch, with brass collars at their ends one and six-sixteenths inch exterior, and fourteen-sixteenths of an inch interior diameter, and flanches to the same, one and nine-sixteenths inch in diameter, fitted with steady pins and set screws for attaching the entire gill to the middle roll. The gills cost three dollars each; the needles can be purchased at $2.50 per thousand. These gills, as well as the larger kind for railheads, drawing frames, and speeders, are made by Messrs. Lanphear, Levalley & Co., at Phenix Village, Rhode Island.

"The yarn spun from this stock makes excellent twine, and can be woven into crash, osnaburgs, burlaps, and sugar cloths; and, when doubled for warp, it makes very superior grain bags.

"Foremost among the cotton mills that have been altered substantially in the way we have described to make some of the above fabrics, are the Hope and Penn mills, of Pittsburg, Pennsylvania, owned by James H. Childs, Esq., and others. The best flax grain bags in the country are made at these mills, and at the same mills are also made very superior stock for battings and for the use of upholsterers. Too much credit cannot be given to the proprietors of these mills for their patriotic and successful efforts to disenthral the north from entire dependence on cotton for these manufactures, and for the encouragement they have given to the owners of other mills to follow their praiseworthy example. The mills at Lockport, New York, owned by ex-Governor Hunt and others, are also producing excellent brown and bleached stock for upholstery, waddings and coarse yarns, as well as twine of a very high grade. The Medina Flax Company's Works, at Medina, New York, are likewise producing goods of a similar character, of superior quality. To this list must be added the mills of Governor Smith and others, in Warwick, Rhode Island, that are making grain bags of excellent quality, besides carpet warps, twine and rugs. There are many other successful pioneers in this branch of flax manufacture obtaining most encouraging results, so that this department of substituting flax for cotton on cotton machinery may be considered no longer problematical, but a success.

"Having thus portrayed what we conceive to be the best mechanical mode of disintegrating, shortening and otherwise preparing flax for coarse yarn stock, and the best mode of carrying such stock through the various processes into yarn on cotton machinery for the manufacture of coarse linen goods, we will next present the results of our efforts, and the efforts of others as observed by us, to cottonize flax by combined mechanical and chemical means to the requisite fineness, evenness and strength for being manufactured into print cloths, shirtings or sheetings, on cotton machinery, either by an admixture of from fifty to seventy-five per cent. of the fibres with cotton, or by their exclusive use as flax-cotton. It is wholly impracticable to disintegrate flax into its ultimate fibre or cells without the intervention of a solvent for the intercellulose or gluten, as previously indicated. And we think it is equally impracticable to rely upon mere mechanical forces to separate the fibres after such disintegration, if they are allowed to become entirely dry before the application of such means. The undecomposed gluten is so unyielding in its nature that, if not partially wet, the separation will inevitably be attended with so much breakage of the fibres as to materially injure the stock. But if they are slightly moist, they readily slide apart into ultimate lengths through the agency of properly constructed pickers that will blow them into a dry atmosphere. It is also just as important, as we have shown, that flax-cotton obtained through chemical disintegration should be prepared exclusively from unretted stock. Some persons say that the filaments of unretted stock are more brittle than those from retted stock, and therefore more liable to abrasion in the preliminary mechanical operations of cottonizing. This, if true, would be incomparably less injurious to the fibre than over-retting, a fault of every-day occurrence in retted straw. Unretted stock will endure soaking, boiling and steaming without injury, while retted, if over-retted, will be easily decomposed; and if it is not over-retted, and is not injured in passing through these operations, the cost of bleaching it, either before or after it is manufactured, will be much greater (besides being attended with more danger of injury) than the cost of bleaching unretted stock. Hence we recommend the discontinuance of further experiments on retted stock for flax-cotton intended for the manufacture of goods, for bleaching or printing, or goods that require the element of durability. We also recommend the postponement of bleaching unretted flax-cotton until it is manufactured into fabrics.

"Specimens of bleached and unbleached flax-cotton, hemp-cotton, asclepias cotton, and China-grass cotton, have been sent by divers persons to the commission, some of them very nicely disintegrated; but three only of all the contributors who have responded to our call have accompanied their specimens with any explanation of the mode of cottonizing, viz: Mr. H. McFarlane, of Rocky Hill, New Jersey, who uses the Claussen process; Mr. Hugh Burgess, of Royer's Ford, Pennsylvania, and Messrs. Fuller & Upham, of Claremont, New Hampshire. Mr. Burgess has not experimented so extensively as the latter gentlemen, but the specimens of both are well disintegrated and separated, or cottonized. The contributions of Mr. Burgess were cottonized from flax of unretted, tangled straw dressed on Mallory & Sanford's 12-roller brake, in the presence of two of the commission, and also from flax of retted straw dressed and cleaned in his neighbourhood. His process for short stock consists, after further cleaning by a suitable mechanical apparatus, in submitting it to the action of soda ash

(or its equivalent in potash) in caustic solution, for an hour, in an iron boiler, (Keen's patent boiler preferred), at a temperature of about 280°° Fahrenheit, the boiler to be heated in any convenient manner, and the mass of flax to be kept under the solution while boiling. The quantity of alkali used is from one-quarter to three-quarters of a pound of dry soda ash to one pound of flax, according to the condition of the latter. After boiling, the mass is blown through the manhole under pressure into a tank, and then the solution is drained off, evaporated, and burned for repeated use. About eighty per cent. of the alkali is saved. The stock, after draining, is washed with hot water until all traces of the alkali disappear. It is then bleached by the use of bleaching liquid percolated through the mass, after which it is washed, squeezed and dried. If long stock is used, it is formed into hanks and put into wire cylinders, which are then placed in the boiler, and, when boiled sufficiently in the solution, the latter is gradually drawn through an opening in the bottom of the boiler, and evaporated and burned as before. The hanks in the cylinders, on being taken from the boiler, are washed, bleached and dried. After drying, both kinds of stock are to be separated by machinery. He has not yet constructed machinery (except models) for reducing the disintegrated fibres or cells to uniformity of length, or for separating them longitudinally, but is experimenting in that direction, and expects soon to accomplish the desired result. His process and product were patented in January, 1864.

"The contributions of Messrs. Fuller & Upham were also cottonized from unretted, tangled straw (which they much prefer to retted), dressed by one passage through Mallory & Sanford's brake. This brake, Fuller & Upham say, removes about ninety per cent. of the shives. These gentlemen, instead of depending on flax-disintegrating, shortening, and cleaning machinery located in flax-growing districts, take the stock from the brake and pass it through a shive-cleaning machine of their own invention, which consists of a series of card cylinders placed in a frame over each other. The stock is fed upon an apron at the bottom, and is carried from the first cylinder to the others successively to the top, where it is delivered from the machine. These cylinders act upon each other as workers and strippers. They are in a screen of zinc placed within three-sixteenths of an inch of the card teeth, having apertures for the discharge of the remaining shives and dirt by the centrifugal force of the cylinders. The latter are all enclosed in a case reaching below the cylinders that receives the waste, which is removed at the bottom. The stock is then placed in a vat with water kept at 90° Fahrenheit for twenty-four hours. The water is then drawn through a grate bottom, and the vat is again filled with water containing one barrel of soap to one thousand pounds of dry fibre, and boiled twelve hours by steam at 212° Fahrenheit, when the water is again drawn as before, and pure water is percolated through the mass the remaining twelve hours. There are two of these vats, that the soaking may be done one day, and the boiling and washing the next, in the same vat, without removing the flax until it is ready for the steaming process. The stock is next transferred in rail cars from the vat to a horizontal iron cylinder having an adjustable head and a perforated movable piston operated by a screw and gears. It also has a large escape-valve at the rear head near the top, and is supplied with steam from a boiler through pipes. It likewise has a pipe to draw off the water and extractive matter. The flax being placed in the cylinder, and the head screwed on, steam at ninety pounds pressure is let on for twenty minutes, when the perforated piston is run towards the head of the boiler, squeezing the stock into a compact 'cheese.' The water-pipe is then opened, and the water with the glutinous matter in solution, that has been pressed through the perforated piston, is blown off. The pipe is then closed, the piston is drawn back, and the escape-valve opened, which permits the steam to escape through the apertures in the piston, and out of the cylinder. Instantly this valve is opened, the steam in the fibres expands, overcoming the cohesion of the softened intercellulose, and filling the cylinder with disintegrated ultimate fibre or cells of the flax. The explosion is recommended to be only sufficiently powerful to disrupt the fibres and leave them measurably in parallel lines; for if they are entirely separated, many of them would be broken, and become, like immature cotton, too short to be profitably spun into yarn. The fibre is then taken from the cylinder, and, when partially cooled, is passed through a compound wringer, consisting of a cylinder eighteen inches in diameter and twelve inches in length, having several rubber rolls that revolve, with the flax passing between them and the cylinder. In connexion with the wringer there is a series of differently speeded drawing rolls that passes the stock between them, drawing it into a thin sheet to facilitate drying and to equalize the lengths of the filaments and fibres. The stock is then put into a box with a grate bottom, under which is a coil of heated steam-pipes.

A rotary fan forces the air into the bottom under the pipes, and through the flax, thereby rapidly removing the moisture. When it is sufficiently dried by this arrangement to allow the fibres to slide apart without sticking to each other, it is passed through an opener which consists of a horizontal cylinder covered with needle-pointed card clothing, with workers covered in the same manner, and placed under the main cylinder, which makes about one thousand and four hundred revolutions a minute, and throws the stock into an adjoining room. The flax is then carried through ordinary gambril cards, and taken off by a railhead with large and strong-corrugated iron rolls, held together by rubber springs, to pull apart any remaining long filaments. It is then passed through a lapper and a fine gambril card, and baled for the market. The mode of preparing this stock, the steaming cylinder, and a considerable portion of the machinery used, are patented, and the entire apparatus is built by the patentees and their partner, Mr. Rice, at Claremont. The price of the apparatus (at present cost of labor and materials) for one thousand pounds of fibre per day, is about fifteen thousand dollars. Parties who may desire to embark in the manufacture of linen goods from stock prepared under the patents of these gentlemen would probably do better, in the beginning, to buy their stock from the owners of disintegrating works.

"There is a difference of opinion among those who have made microscopic examinations of the texture of flax fibres as to their composition. While all agree that they are cellular, and have transverse lines at variable distances, some think the lines are pores through which the interior moisture is evaporated in drying, and that the cellulose structure differs sufficiently from the structure of the intercellulose to allow the decomposition of the latter without injury to the former; others that the transverse lines indicate the growth of the cells, like cane joints; and that the composition of the cells is so nearly akin to the composition of the intercellulose, that both cannot be more than partially decomposed without so materially impairing the strength of the former at the marks, and intermediately, as to render them too weak for manufacturing. It is evident to us that the union of the cellular and intercellular matter is so thorough that while the former may be relieved from the tenacious hold of the latter, there should always be left enough of the intercellulose adhering to the cellulose after disintegration to keep the cells together until they are separated, if in a moist state, by sliding them apart through the intervention of pulling rollers; or if in a dry state, by the application of a picker to break them apart. The probability is that if the decomposition of the intercellulose is complete, or nearly so, the fibre would be much injured, if not destroyed. Hence the absolute necessity, in cottonizing, of using unretted flax, which always has fibre reliable for strength in any high steam process of disintegration if properly prepared.

"The opinion of the commission has often been asked upon the relative durability of goods made of long-line flax, or flax-cotton, and the relative strength of goods made of the latter to goods made of cotton. From such examination as we have been able to give the inquiry, we think that goods made from sound, long-line stock, when new, will be stronger than those made of well-prepared flax-cotton, in consequence of the excess of glutinous or intercellular matter in long-line yarns; but that as flax-cotton goods will be softer and less liable to crack when new than goods of long-line, while each ultimate fibre will be as strong, there is every reason to believe that they will be more durable, besides having the advantage of flowing more gracefully when made into garments; and as the fibres of flax-cotton are much stronger than the fibres of cotton, and much more soft and silky, fabrics made from them must not only be stronger when new, but more reliable for service than cotton goods.

"In addition to the probable greater durability of flax-cotton fabrics over those made of cotton, is the important fact of their superior ability to receive and hold colors. This is supposed to be caused by the difference in the shape of the fibre of the two plants. We have remarked that both are tubular; but the wall of a flax fibre being thick, its tubular form is permanently preserved, while the wall of cotton fibre being thin its tubular form in drying becomes flat spirally, like a twisted ribbon; consequently it presents only a flattened surface to receive and retain color; and hence it is always less brilliant, even when first dyed, than a flax fibre, the tube of which excludes the air, and by its transparency, reflects the colour strongly, while its closed condition shields the color from the fading influence of the atmosphere.

"The flax-cotton of Messrs. Fuller & Upham has been spun on cotton machinery into about No. 24, (cotton gauge), and also woven in the form of weft into print-cloth. To spin it successfully it will be necessary to alter the lapper and cards in the manner

indicated for coarse yarns, and to reduce the number and draught of the drawing heads. One head with a draught of one inch into four inches will probably answer between the rail head and speeders. The middle top rolls of the rail and drawing heads and speeders must be relieved of a portion of their weights. The middle top rolls of the spinning frames must be wholly relieved of their weights, which can be done by substituting single saddles from the front top to the back top rolls for the double saddles generally used, unless the back top rolls are of smooth iron about one and a half inch in diameter, in which case the front rolls may be weighted with a hook and lever weights, and the back rolls be left without weights.

"As cordage and for twines, to which, in the cheaper days of cotton, that substance was extensively applied, hemp and flax still assume their pre-eminence and superiority. Even to the grocer's twine, which must be short and easily broken, these fibres have been extensively and profitably applied. Every variety of twine is now made of flax and tow in several establishments. Thread of the best quality for many purposes is also prepared from this material, and for some branches of the arts it has always been deemed superior to cotton. Coarse linen fabrics of every description, from bagging down through burlaps, crash, duck, diaper, &c., have all been successfully made of flax and hemp, where formerly the greater cheapness of cotton had caused that fibre to supplant its legitimate competitor. In the article of seamless grain-bags, which were formerly made altogether from cotton, we now have a much better article produced from flax. The nicely prepared battings of flax, whether bleached or unbleached, have taken the place, to a great degree, of the application formerly made of the dirty and refuse cotton for this purpose; but the greater weight of the flaxen material depreciates its value and usefulness when to be applied in this way, for a given number of pounds of flax batting will cover a space but half as large as an equal quantity of carded cotton.

"It would not be consistent with the limits of this report to take up the discussion of the whole subject of paper-making, although its main feature depends upon the value of these very fibres we have been examining. As in its production, however, flaxen and hempen fibres may very advantageously be substituted for those of cotton, we may be pardoned for making some allusions to this matter. As before intimated, all of these several fibrous substances are composed of nearly pure cellulose, and thus, in their ultimate composition they are very much alike. It further appears that whatever materials be used for paper-making, their value will depend upon the amount of this proximate principle of cellulose which they contain, and whether the stock consist of solid wood, hollow straw, fresh fibre of bast cells from our flax fields, waste cotton from the factories, or worn-out clothing and old ropes, made from these different fibres, their value in every case depends upon the amount of pure cellulose which can be derived from them. The cellulose from the several sources appears to exist in nearly the same proportions, about fifty per cent., whether we take the wood or the straw for the raw material.

"The union of these fibrous substances in the tissue of paper depends upon a peculiar condition which has been imparted to them by the action of the paper machine, so tearing and breaking the cells and fibrils, and fraying their ends as to give them a sort of felting property—quite different, it is true, from what is described as felting, in another part of this report, but still enabling the ends of the fragments to unite with one another so as to form a tissue of more or less consistency, according to the nature of the materials used.

"An application of flax as a substitute for cotton, which was little expected, presented itself in the formation of hard rolls for print-works and bleacheries. In the construction of these rollers it had been a desideratum to get a hard and elastic surface. This was first accomplished by disks of heavy paper closely applied to one another upon a shaft, firmly compressed and then turned into shape. Next, cotton itself was used; but it is now found that flax fibre may be applied to this object with the most satisfactory results.

"One of the greatest claims which flax presents to our notice is its ability to replace cotton, and with great advantage, too, in all the cases where that substance was formerly used in combination with wool in the production of mixed fabrics. Hempen and flaxen yarns are now resuming their original importance in the manufacture of carpets, both alone and when used as the warp only, of those useful tissues, in which cotton had entered as the leading article."

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